ARMY ORDNANCE

VOL. XXVI, No. 143 MARCH-APRIL, 1944

For the Common Defense
Charles E. Wilson

America's First War Planner
Brig. Gen. John McAuley Palmer

Aircraft Gun Turrets
Marcus W. Bourdon

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Small Arms Inspection
Lieut. Col. M. L. DeGuire

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

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ARMY ORDNANCE

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Founded 1920

For Victory through Armament Research, Production, and Supply

Volume XXVI MARCH-APRIL, 1944 No. 143

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THE ARMY ORDNANCE ASSOCIATION

The Aims, Purposes, and National Officers of the Society

THE Army Ordnance Association, a national society of over 20,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-four years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peace-time armament industry in the United States for the production of ordnance. Now all American industry is geared for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns, this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is four dollars a year. (Application facing p. 328.) There are twenty-two local chapters of the Association throughout the United States.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guaranties of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers and manufacturers in civil life and the Regular and Reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

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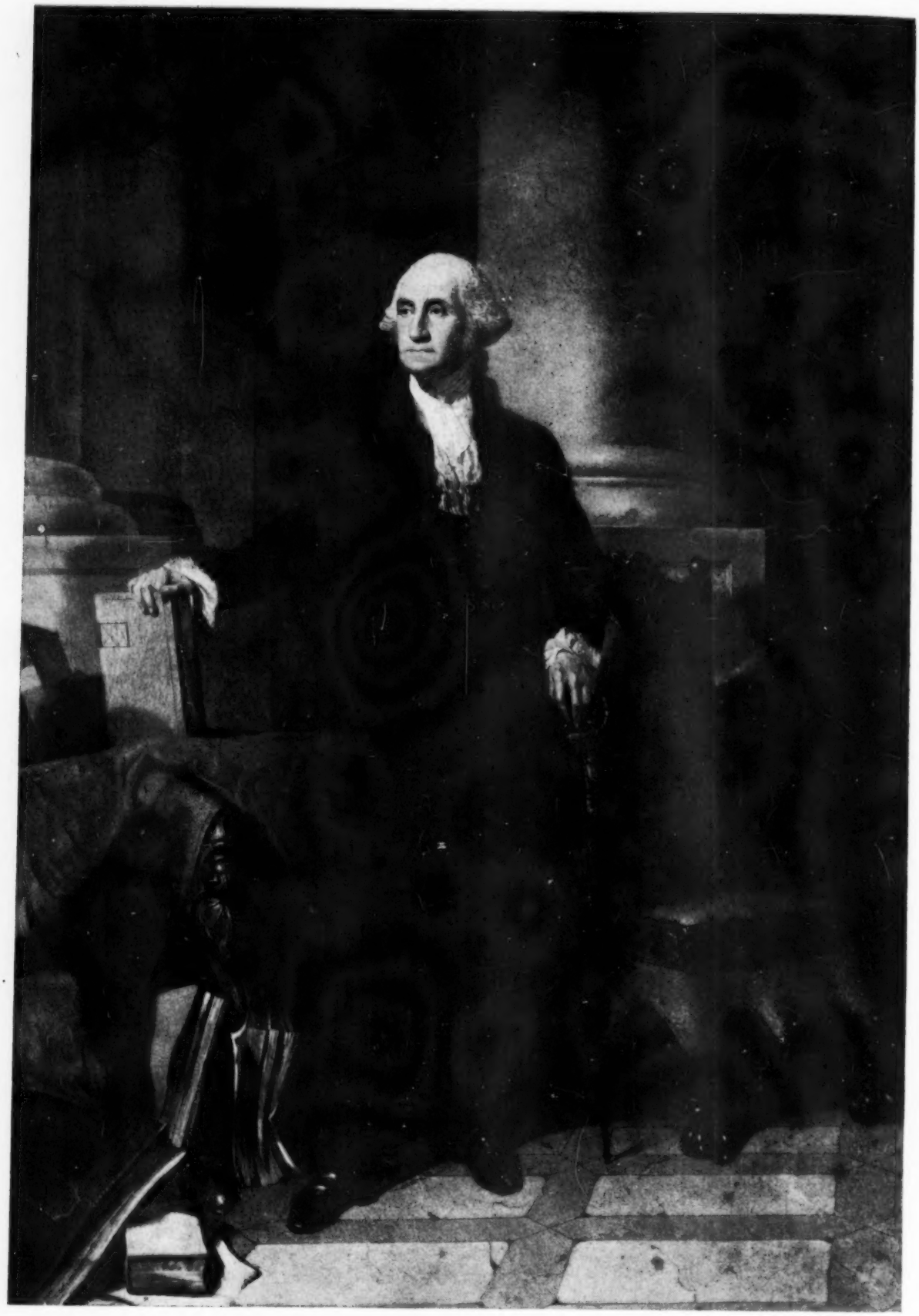

George Washington—America's First War Planner

ARMY ORDNANCE

Volume XXVI MARCH-APRIL, 1944 No. 143

For the Common Defense

A Plea for a Continuing Program of Industrial Preparedness

Charles E. Wilson

DURING the last two years we Americans have been learning in the hardest of all schools—the school of bitter experience—in which many of the key textbooks, unfortunately, were written by our enemies. We are paying a stiff price for that knowledge and will continue to pay until the last life, the last sacrifice, and the last dollar have been entered in the ledger. That will not be in our time. Twice in one generation this has been our common experience. The first time we flunked the course. I think it is fair to say that the reason we are here tonight is not only to honor the Army Ordnance Medalists for their past achievements but to survey once more the circumstances that have made those achievements necessary and to build upon them, if possible, a structure of peace and preparedness that will prove more durable.

In the preamble to the Constitution of the United States we may find our text in these words: "We the people . . . in order to provide for the common defense . . ." That is a highly important fragment of a great document—one which our enemies have never understood. We tend to forget it ourselves until we are thrown into fighting for our lives. This is the people's war—all of them, all of the time—not just the Army's, or the Navy's, or labor's, or industry's war. We know now that industrial and economic wealth does not of itself mean military strength. It becomes striking power only when it is organized and directed. When that organization and direction are too long delayed, we pay a tremendous price, which is a sort of discount in blood to penalize us.

Make no mistake—I think we have done a magnificent job in the last two years. We have learned in the hard school of war how to make the utmost use of the energy, the resources, and the intelligence with which God has blessed us. My quarrel, and yours, is with that bloody discount, exacted from us as a people because we mistakenly thought that a simple desire to remain at peace would be adequate protection against war-mad aggressors.

I should like to frame what follows in three sections: first, to review briefly some aspects of this war and the way we are fighting it; secondly, to draw a few lessons from that review, and, finally, to put before you a program that I hope you will consider in principle, rather than form.

The enemy set the opening date for our war. That has always been the fate of a democracy which prefers peace, and we must accept it as standard practice. The Axis nations stole a march on us in the matter of industrial mobilization and had their economies geared to war long before we awoke to our danger. They made lavish display of munitions and equipment in the war's early stages while we trained troops with stovepipe cannon and wooden rifles.

In our painful humiliation we overlooked the fact that they were equally far ahead of us qualitatively. They had better, as well as more, weapons. That is not to say that we did not carry on research and development in military fields, because we did. I shudder to think what might have happened to us these last two years if it had not been for the intelligent, patient, and devoted work done in the years of peace by Army Ordnance officers, among others. But the scale was small, the thoughts of the Nation were elsewhere, and the improvement of our means of defense received, between the last war and this one, a pitifully small part of the country's scientific and engineering attention.

From our earliest days, the fundamental training in engineering and tactics provided by West Point and the Naval Academy has been of the best, but we have not made really adequate provision to keep our services abreast of the swift advances in science and technology. The truth is that peace is our business—not war. Our skills have been aimed at a better life, not better weapons of death.

General Campbell has declared that our armament program began two years before Pearl Harbor. He and all of us are proud of the fact that never once has our production been out of step with battle requirements. However, during the transition period from the production of peacetime articles to wartime devices there were costly delays. I am convinced —and hope to document this as we proceed—that not only could those delays have been prevented by an intelligent preparedness program, but such a program might itself have acted as a deterrent. The Industry-Ordnance team, with its endless production of weapons, blasted the hopes of our enemies in the last war; it is repeating the performance for the German and Japanese military leaders in this one.

THE outstanding features of this war, after the sweep of the German war machine over Europe and that of the Japanese over eastern Asia, have been the dogged courage of the British people, the heroic stand of Russia, and the flood tide of America's war production . . . The influence of top management, and its importance in getting results, cannot be overestimated. With all modesty, and in the name of the thousands of management experts throughout America who literally have accomplished miracles in spite of technical difficulties and insufficient and inadequate equipment, I am in accord with their policies. But has it ever occurred to you that really good managers, in government or business, would never have allowed their own businesses to operate as haphazardly and spasmodically as has the business of defending the United States against its enemies?

Mr. Wilson is Executive Vice-Chairman of the War Production Board. This is an address delivered at the Twenty-Fifth Anniversary Dinner of the Army Ordnance Association at the Waldorf-Astoria Hotel, New York City, January 19, 1944.

In industry we chart our sales and orders and keep a weather eye on material sources and market trends from year to year. Even the company that keeps my fuel-oil tank supplied can tell me ahead of time when I will need oil. Yet when it comes to the vastly important and tragic business of war, we shut our eyes and stop our ears until it is so late that top management has to perform miracles, and men die while waiting for them.

It might pay to look at some examples. Our armed services went to war with a good line of communication equipment which had been designed for them by about five of the larger manufacturers. None of these companies carried on any major research or development on military products —for the very good reason that the services were so restricted as to procurement or equipment that no manufacturer could risk his stockholders' money that way.

As war approached, these manufacturers were given orders and presently had to expand their facilities and develop subcontractors. These steps should have been taken earlier. They, in turn, would have speeded the stoppage of domestic production. Finally, the large engineering companies were asked to take on research and advanced engineering projects. These companies responded all too slowly, because their minds were not on war problems and because the military people were not too sure what equipment might be required. The net result of these developments is an industry producing $250,000,000 in electronic equipment a month, with amazing progress still going on. But there *had* been a costly delay. Consider for a moment the lives and money that could have been saved and the perils that could have been averted if the antisubmarine devices now available had been ready in the summer of 1940.

HERE is another example: Nothing was more critical than the machine-tool industry from 1939 through 1942. Most of the tooling for war production was based on the feeds and speeds of high-speed-steel tools. With the single exception of the shell-production program, most armament materials that had to be machined were worked with outdated tools that subsequently were discarded at great expense. To achieve a stipulated production under this arrangement, too many machine tools were needed—sometimes twice the number that would have been required with carbide tools. When the latter were substituted, the plants produced far more than their expected capacity. The reason for this situation was that not enough Ordnance officers had had an opportunity to keep abreast of modern metal-cutting practices.

So much for examples. The blame, such as it is, lies not with specific services, or contractors, but with our approach as a people to war.

When we look ahead toward future security for our country, we realize that simply to prepare for the mass production of military goods is not enough. It can be terribly costly to let a potential enemy get the lead in the production of weapons; it is costly, and demoralizing, to let him get the lead in research and development which precede production.

The war economy that harnesses all of a nation's immediate strength for conflict must also harness its scientific and engineering knowledge and ability far in advance. The research that gives us qualitative superiority over an enemy can never again be left to the time when war has arrived, considering the terrible acceleration which science has given to this conflict. It must be a continuing process in peace.

It is an ironic comment on modern society that much of our truly significant scientific and technological progress occurs in wartime. The irony is not averted by the fact that subsequently the new knowledge is translated into peacetime advantages. For instance, we have been twenty years converting the raw, telescoped electronic developments of the last war into things like broadcasting and ultraviolet therapy and X-ray inspection. Under the pressure of war men move fast and dig deep. They are not always aware of what they find, because there is no time to examine it. But when normal times return, the research, development, and testing is transferred to peacetime objectives. Compulsion is removed. What had been everybody's business is quickly resigned to the few who concern themselves with military and naval matters. This is natural because science operates in a vacuum rarely invaded by politics and economics. It does not concern itself so much with ends as with methods. But, in any case, the inevitable tendency is for science and engineering to progress the fastest in those fields remote from the Army and Navy.

IT is obvious that this process will repeat itself unless we readjust the machinery somehow. I hope and pray that when this war has been won we shall lay the foundations for an enduring peace. I hope and pray that we shall have the good sense to build on that foundation, so that the dreadful curse of war does not descend upon us again after two or three decades. But hope and prayer are not enough in an uncertain world. We must have insurance against disaster. The development of new weapons and new instruments of terror and destruction must never again be the field in which the men who want to gain by war outstrip the men who dream of a world at peace.

Perhaps it is time for some fresh thinking on this matter of war and peace. Instead of looking to disarmament and unpreparedness as a safeguard against war—a thoroughly discredited doctrine—let us try the opposite: full preparedness according to a continuing plan. The thought may be unpleasant, but through the centuries war has been inevitable in our human affairs. We have yet to learn that hard truth.

I am not proposing a doctrine of aggression and brutality —simply a realistic point of view that the tendency to war is inevitable, just as the human tendency to disease is inevitable. But we do not sit and wait for the latter to strike us down. Perhaps we should even abandon that false phraseology of a "war economy" and a "peace economy." We do not have, individually, a "sickness economy" and a "health economy" in respect to the care of our bodies. One of the acknowledged glories of our age is preventive medicine.

It is interesting to apply this thinking to weapons. Take poison gas, one of the most disturbing and terrifying weapons of the last war. It was almost the first to be outlawed by international agreement, but none of us stopped there. For once we were practical, and, as a result, every country in the world assigned its chemists to the study of gas and its defensive complements. Actually, we believe today that gas is a minor weapon, relatively ineffective—but, as a result of this intensive attention, gas has yet to be used, except for isolated instances, in this war. No practical person attributes this to moral or humane reasons.

The experience of two years has shown conclusively that industry, coöperating with the Army and the Navy, makes for a very effective combination, a combination that should be extended into the postwar period to the end that we might maintain at all times leadership in the technical and

operational superiority of the implements of war. Should the world know that we were in that position, that we were determinedly keeping the fires of scientific and developmental effort burning and that we were ready to shift our industry quickly to the production of these thoroughly tested superior weapons, the probabilities of another Mussolini, Hitler, or Tojo undertaking to conquer the world will be much more remote.

Certainly this production front, which today has some twenty million people in its command—approximately twice the number we have in uniform—is as deserving of a continuing general staff operation in peacetime as the Army and Navy. More than that, it demands such continuity if the services themselves are to be kept effectively ahead of their job. Once war is imminent, it is too late to draw full and immediate benefits from our civilian research, engineering, and production techniques in the creation of war products.

First, we must learn what is needed to cope successfully with our enemies. Almost at the same time we must develop and produce equipment which will be superior to theirs. Good planning would anticipate this situation, so that when an emergency arrives we should only have the problem of increased production of equipment already developed and proved. As part of this program there would always be, in the hands of the Army and Navy, a sufficient amount of this equipment so that a nucleus of our forces would have been trained in its tactical use.

I am indebted to Mr. R. E. Gillmor, president of Sperry Gyroscope Company, and a Navy man himself, for the pertinent observation that ever since the days of Mahan, our country has recognized the principle of a "fleet in being," as an instrument of national policy in both peace and war. What is more natural and more logical, in view of the increased mechanization of war and in view of the fact that the scientist and the mathematician are the ones who put our fighting planes in the sky and plant our shells in the hearts of enemy cities, than that we should henceforth mount our national policy upon the solid fact of an industrial capacity for war and a research capacity for war that is also "in being." It seems to me that anything less is foolhardy.

Consider, if you will, what is involved in the development and production of a plane or ship, of an automatic turret, a fire-control device, an electronic-detection system. Think of the long years of trial and error, approximating a quarter of a century, that gave us the turbosupercharger. . . . Given only a layman's knowledge of the weapons involved in the present conflict, of their intricate and ingenious design, and their terrible capabilities, how can we help but be appalled at the thought of the weapons which the next war, if and when it comes, will bring forth. The power to destroy will be greatly magnified; the time to prepare an adequate defense will be tragically shorter than it was in this war. Perhaps there will be no time. Where will that leave our vaunted power to perform miracles of development and production on short notice?

The leaders of industry are as much the leaders of their country as are the generals, the admirals, the legislators, and the chiefs of state. Their responsibility for postwar preparedness is certainly no less. The burden is on all of us to integrate our respective activities—political, military, and industrial—because we are in world politics to stay, whether we like it or not. Any latent ability we may have to procure for our children a durable peace will not be impaired by our ability to wage war victoriously and at a moment's notice.

I am well aware that sentiments such as these have traditionally been met by the cry of "Warmonger!" I know, as you do, that the revulsion against war not too long hence will be an almost insuperable obstacle for us to overcome in establishing a preparedness program, and for that reason I am convinced that we must begin now to set the machinery in motion while it is still possible for us to measure the cost of any other course. The peaceful temperament of the American people is well known. We can possess the mightiest and deadliest armament in the world without becoming aggressors in our hearts, because we do not have that intoxicating lust for blood and power which periodically transforms the German military caste.

I HAVE no hesitancy in submitting the following rough outline of a program. It is meant as a challenge, or an invitation to action. Certainly the details are open to argument and change. If they serve no other purpose than to stimulate and arouse all of us to our intelligent and patriotic duty, they will accomplish their purpose. I sincerely hope that there are those among you who will exert yourselves, if you agree with me, to see that the proper administrative and legislative groups are not kept in ignorance of our sentiments.

As a preliminary to even these tentative suggestions, I would like to make some general observations which apply, it seems to me, to whatever form such a plan might take. First of all, such a program must be a responsibility of the Federal Government. It must be initiated and administered by the Executive Branch—by the President as Commander in Chief—and by the War and Navy Departments. At a somewhat secondary level, it is obvious that the Labor and Commerce Departments would also be vitally interested. Of equal importance is the fact that this must be, once and for all, a *continuing* program, and not the creature of an emergency. In fact, one of its objects will be to eliminate emergencies so far as possible.

The program must be insured and supported by the Congress—in the beginning through resolution or perhaps even through legislation; later, by regularly scheduled and continuing appropriations. Industry's rôle in this program is to respond and coöperate. Industry must be *allowed* to play its rôle. By that I mean that it can act only on request or authorization of government. In the execution of the part allotted to it, industry must not be hampered by political witch hunts, or thrown to the fanatical isolationist fringe tagged with a "merchants-of-death" label. Let us make this 3-way partnership permanent and workable, not just an arrangement of momentary convenience.

Next, it is apparent that the proposed program falls into two parts: *research* and *production*. Both have the ultimate objective of continued preparedness, but the methods and resources of each vary considerably. It will be most convenient to consider these functions separately.

Some of us have been particularly aware of the operations of the Office of Scientific Research and Development, under which science has been so ably mobilized during the present emergency. Although the work of the OSRD has been secret in nature, certain aspects of the organization recommend themselves as worthy of consideration for a long-range program. For one thing, existing facilities in industry and in universities are employed for research projects. The work is directed by a board composed of both civilians and Army and Navy officers, with the result, as the *New York Times* reported, that "the natural conservatism of the Army and

Navy is offset by the more imaginative approach of physicists and engineers who never smelled gunpowder in action—men who know what science can do when given half a chance."

THE points worth stressing and recommending for a long-range plan are these: Use existing facilities and bring together at some level the research activities of both civilian and service groups. We already have a number of good governmental institutions in operation—the Naval Research Laboratory, the laboratories of the Army and Navy Air Forces, the Army and Navy Ordnance laboratories and proving grounds, the Research and Development Division of the Quartermaster Corps, the Chemical Warfare Service, the Bureau of Standards, and others. These should certainly be kept up. Their usefulness might be increased and their outlook broadened if they were equipped with committees of competent, responsible civilian advisers, appointed by some such agency as the National Research Council for regular 3-year periods, with one-third retiring each year. One of the responsibilities of such a committee would be to keep its assigned institution in close liaison with industry and with the other Government laboratories.

Finally, the chairmen of the various institutional committees, together with high-ranking officers of the Army and Navy, would compose a general committee for continuing postwar research and development. This would not only maintain contact between industrial laboratories, schools, and Government institutions but would guard against compartmentalism and departmental secrecy among service branches. Such a group could formulate and recommend developmental contracts or research projects between Government and various industrial or college laboratories, wherever the best facilities presented themselves. It would be unwise to attempt any consolidation of Government research institutions, since the definite responsibility which each has in its own field is a real stimulus. The general committee would correspond to a small staff group.

Let us leave the research half of the program at this point, and briefly examine the production phase of the problem. In a sense, production is the more critical element, since it entails far more people and facilities at its peak usefulness and must be readily expandable. Suppose the largest suppliers of war goods (the exact number to be determined by a study of the present program) were each asked to designate a permanent liaison man, generally familiar with war-production requirements and with his own company's developments and capabilities. Such a man would keep ready at all times a broad plan for converting and reëquipping his company, setting up subcontractors, assuring material supply—in short, doing everything that he or his prototype is doing today as an emergency assignment in the country's best-run businesses. The services might insure his added interest by commissioning him a colonel in the Reserve which would bind him closer to them and give him added stature within his company in peacetime. Out of this group of "colonels" there might be chosen an industrial coördinating committee to serve in conjunction with the principal procurement officers of the service branches. This committee would parallel the general research committee. Both would be permanent and continuing, although the personnel would change, perhaps, and either group, or both, would meet on regular occasions with designated legislative and administrative representatives at the President's behest.

What we have here, of course, is a consultative group which carries into peacetime the Combined Chiefs of Staff idea which is proving so successful in wartime. Each participant draws inspiration, information, and advice on which to act—not as a member of the committee but in his own capacity as a Congressional committee chairman, as an industry representative, as a Cabinet member, as a scientist with access to research facilities. The staff is clothed with no separate powers; it draws its power from the individuals who make it up.

This is about as far as it is possible to go with respect to organization. I would like to conclude with some footnotes which seem appropriate.

It is my feeling that both branches of the service should keep their technical officers in closer touch with manufacturing plants through assigned tours of duty. The Navy has been the leading exponent of this practice, I believe. It is not a costly thing to do.

In respect to Government research projects, the remuneration for scientists on the Government pay roll should be so substantial as to attract leading men and the positions sufficiently recognized as to keep them. Industry has set the pattern here.

AS for Government-owned plants, some of these undoubtedly should be retained in stand-by condition for future use. But we must bear in mind that little is to be gained by reserving and maintaining huge plants for the production of highly specialized weapons and equipment, because they will almost certainly turn into the whitest of elephants. So long as warfare is global in character no man can foresee the nature of future weapons, which tend to grow out of the demands of a particular theater of war. It would be preferable to authorize a steady flow of educational orders for small amounts of new equipment so that those companies which would have to swing into volume production might keep their hands in and be ready for expansion. This would be a natural by-product of the general postwar staff operation.

All this has largely been a somewhat documented elaboration of one word—coöperation—between Government and industry. It is the kind of coöperation we are getting now but continued with the expensive peaks leveled off and much of the headache eliminated. No bureaucratic structure has been proposed which would in any way limit or modify the will of the people as expressed through the Congress and executed by the Administration.

We have learned that our country has the strength and brains to do anything it needs to do, provided that it brings the strength and brains together and makes the proper use of them. As we love peace and long for its continuance, it is our responsibility to make sure that America's strength and brains, its craft and knowledge, are kept forever ready—not just ready *for* action but *in* action.

I do not know, and it is not my place to advocate, whether or not we need a huge armament program. But the high importance of this plan of keeping scientifically and technologically ready for war lies in the fact that it does not involve the maintenance of large armed forces. Nor would this program be very expensive. It would not depend upon universal military service, although that offers many advantages, or upon large-scale production of military goods. It can fit into our peacetime way of living without difficulty. I believe with all my heart that it would *guarantee* that way of life.

America's First War Planner

Washington's Program for Military and Industrial Preparedness

Brig. Gen. John McAuley Palmer

THE world today is deluged with plans for its better organization, either for bringing the current war to a quicker and more satisfactory conclusion or to make it a better place in which to live after that consummation has been effected. Some of these plans are official; many are without governmental support of any kind. Lest it seem that planning is something new in the world and may shortly lead us to Utopia, it is not amiss to call attention to the fact that plans for the better ordering of human relations date back at least to the time of Plato (428-348 B.C.). Plans are themselves human institutions and are subject to all the vicissitudes of other human institutions in their execution. The following story is an illustration of an excellent plan which failed of adoption, apparently because its submission was inapt and it ran afoul of certain group interests.

As early as May 2, 1783, Gen. George Washington, then in camp at Newburgh, N. Y., with the Continental Army, submitted to a committee of the Continental Congress, at that time in session in Philadelphia, what was in effect a plan for the military and industrial preparedness of the Colonies. This, it may be observed, was more than five years before our present Constitution was ratified by New Hampshire on June 21, 1788.

The steps leading to General Washington's plan, which he submitted under the title of "Sentiments on a Peace Establishment," were initiated by a letter dated April 9, 1783, from Alexander Hamilton, chairman of a committee appointed by Congress "to consider what arrangements it would be proper to make in the different departments with reference to a peace." This was ten days before the formal cessation of hostilities with Great Britain. In this letter, Hamilton wrote:

"The committee wish Your Excellency's sentiments at large on such institutions of every kind for the interior defense of these States as may be best adapted to their circumstances and conciliate security with economy and with the principles of our governments. In this they will be glad if you will take as great latitude as you may think necessary, and will therefore omit entering into any details.

"The committee apprehend it to be the intention of Congress to lay down a general plan to be carried into execution as circumstances will permit, and that in attending to such disposition as the immediate situation of the country may require they are chiefly desirous of establishing good principles that will have a permanent salutary operation."

Upon the receipt of this letter, Washington transmitted its substance to the other generals at or near Newburgh and directed each of them to submit his written "sentiments" on the subject at issue as soon as possible so "that I may compare them with my own and be able to comply with the request of the committee in as full a manner and with as little delay as can be."

The officers consulted by Washington were Generals von Steuben, Knox, Huntington, Pickering, Heath, Hand, and Rufus Putnam. Their replies may be found in their chronological order in the Washington papers in the Library of Congress. The most striking thing about them is their unanimity as to the military needs of the United States. This indicates that national military organization had been the subject of thoughtful study and frequent discussion at Washington's headquarters. With one exception, they all recommended that the militia (that is, the national man power) should be given uniform organization and effective training throughout the States. They agreed that a well-regulated militia, so formed, would be a sufficient basis for an effective national defense.

They also agreed that there should be a small Regular Army to garrison the posts on the Indian frontier and for other special duties that cannot be performed by citizen soldiers in time of peace. In his letter to the Commander in Chief, dated April 22, 1783, General Pickering stated this consensus of opinion as follows: "We must have recourse for our general defense by land to the only palladium of a free people—a well-regulated and disciplined militia. I say for our general defense, because some permanent establishments, for the protection of our frontiers and the security of our magazines, will be necessary, independent of the militia."

PICKERING and the other generals, with one exception, were all Americans of English descent and citizen soldiers. It is, therefore, not surprising that they should be imbued with the Anglo-Saxon doctrine of reliance upon militia. But how would Baron von Steuben reply to Washington? He was a trained professional soldier who had spent his early manhood in the Prussian Army under Frederick the Great and had devoted his life to the scientific study of military institutions, tactics, and organization. Would Steuben be tinctured with the militia heresy?

One week after receiving Washington's letter, Steuben submitted a report giving his views on the military policy of the United States. His statement was even more concise than Pickering's: "A chain of small posts along the frontier as much for the protection of trade as to be a check for the Indians, a well-organized militia, and the establishment of military schools and manufactories is all that will be necessary for our security." In his letter of transmittal he wrote: "A system of this nature will make us more respectable with the powers of Europe than if we keep up an army of fifty thousand men." Steuben also emphasized the fundamental importance of the militia in his conception of a proper military policy and suggested certain details of tactical organization.

After consulting the papers submitted to him by his generals, Washington wrote a treatise on the military policy of

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General Palmer is a retired officer of the Regular Establishment. He graduated from the Military Academy in 1892. His distinguished service has included tours of duty in Cuba, in China during the Boxer Campaign, and in the Philippines where he was governor of the District of Lanao. He has served in the Infantry, on the General Staff, on the staff of General Pershing, and as military adviser to the Senate Committee on Military Affairs. In addition to the Distinguished Service Medal, he holds numerous other medals and decorations, both American and foreign. He has done outstanding work as a military historian and at present is on active duty in an advisory capacity to the General Staff.

Much of the material in this paper has been published previously and it is to the courtesy of the Yale University Press that we are indebted for permission to use it freely in the present article. The whole story of the legislative history of our basic defense policy, or lack of policy, is well told in General Palmer's "America in Arms."

the United States under the title, "Sentiments on a Peace Establishment."*

ON the first page of this document he summarized his subject as follows:

"A peace establishment for the United States of America may in my opinion be classed under four different heads; *viz.*,

"First, a regular and standing force, for garrisoning West Point and such other posts upon our northern, western, and southern frontiers, as shall be deemed necessary to awe the Indians, protect our trade, prevent the encroachments of our neighbors of Canada and the Floridas, and guard us at least from surprises; also for security of our magazines.

"Secondly, a well-organized militia upon a plan that will pervade all the States, and introduce similarity in their establishment, maneuvers, exercise, and arms.

"Thirdly, establishing arsenals of all kinds of military stores.

"Fourthly, academies, one or more for the instruction of the art military. . . . Also manufactories of some kinds of military stores."

WASHINGTON AT HOME
From Painting by Alonzo Chappel

In connection with his first heading, he says: "Although a *large* standing army in time of peace hath ever been considered dangerous to the liberties of a country, yet a few troops, under certain circumstances, are not only safe but indispensably necessary. Fortunately for us our relative situation requires but few. . . . Our *distance* from the European states in a great degree frees us from apprehension, from their numerous regular forces, and the insults and dangers which are to be dreaded from their ambition.

"But if our danger from those powers was more imminent, yet are we too poor to maintain a standing army adequate to our defense, and was our country more populous and more rich, still it could not be done without great oppression of the people. Besides, as soon as we are able to raise funds more than adequate to the discharge of the debts incurred by the Revolution, it may become a question worthy of consideration whether the surplus should not be applied in preparations for building and equipping a Navy, without which in case of war we could neither protect our commerce nor yield that assistance to each other, which, on such an extent of seacoast, our mutual safety would require."

After an exhaustive survey of the Indian frontier from the Penobscot to the remote far west, then known as the "Illinois Country," Washington completed his proposed organization for the Regular Army. He recommended 4 small regiments of infantry and 1 small regiment of artillery with a total strength of 2,683 officers and men. Although he relied upon citizen soldiers for the general defense, he found that some professional soldiers were necessary. He therefore proposed enough professionals to do these things that manifestly cannot be done by citizen soldiers. He wanted *enough* professional soldiers for these special purposes but no more. This was the crux of Washington's military policy.

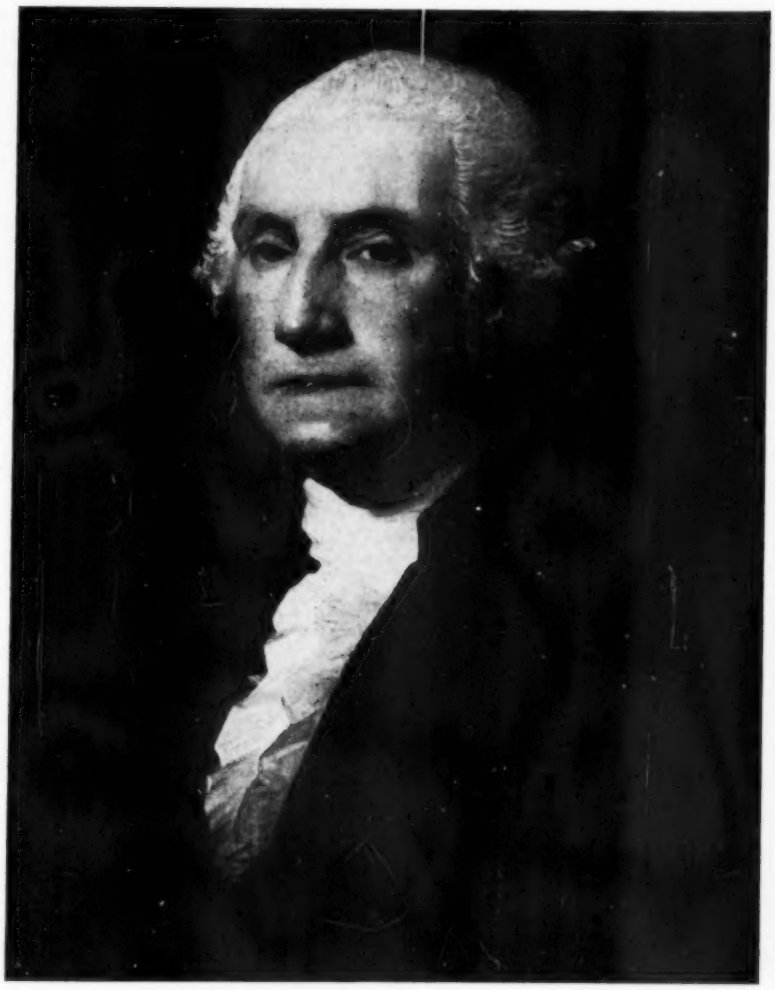
HAVING indicated the proper function of the standing army, Washington then took up the main feature of his national-defense policy:

"I come next in the order I have prescribed myself to treat of the arrangements necessary for placing the militia of the continent on a respectable footing for the defense of the empire, and, in speaking of this great bulwark of our liberties and independence, I shall claim the indulgence of suggesting whatever general observations may occur from experience and reflection with the greater freedom, from a conviction of the importance of the subject; being persuaded that the immediate safety and future tranquillity of this extensive continent depend in a great measure upon the peace establishment now in contemplation; and being convinced at the same time that the only probable means of preventing hostility for any length of time and from being exempted from the consequent calamities of war is to put the national militia in such a condition as that they may appear truly respectable in the eyes of our friends and formidable to those who would otherwise become our enemies.

"Were it not totally unnecessary and superfluous to adduce arguments to prove what is considered on all hands the policy and expediency of resting the protection of the country on a respectable and well-established militia, we might not only

*This highly constructive state paper lay buried in manuscript form for 147 years and was not given to the public until General Palmer found it among the Washington Papers in the Library of Congress and published it in 1930 as an appendix to his "Washington, Lincoln, Wilson: Three War Statesmen." Since then it has been published in the Bicentennial Edition of the "Writings of Washington."

show the propriety of the measure from our peculiar local situation, but we might have recourse to the histories of Greece and Rome in their most virtuous and patriotic ages to demonstrate the utility of such establishments. Then, passing by the mercenary armies, which have at one time or another subverted the liberties of almost all the countries they have been raised to defend, we might see with admiration the freedom and independence of Switzerland supported for centuries, in the midst of powerful and jealous neighbors, by means of a hardy and well-organized militia. We might also derive useful lessons of a similar kind from other nations of Europe, but I believe it will be found the people of this continent are too well acquainted with the merits of the subject to require information or example."



GEORGE WASHINGTON—FIRST PRESIDENT

When Washington outlined his military policy in 1783, the enrolled militia of the Thirteen Original States numbered more than 400,000 men. It would have been impossible to train and arm this mighty host and there could be no need for such vast numbers even if they were trained. On the other hand, there were more than 100,000 able-bodied young Americans under the age of 25. The obvious solution was to segregate a sufficient number of these youngsters and give them effective organization and training in time of peace. With this done, the Continental Army of the future would always be ready for a military emergency of almost any kind.

But though the solution was simple from the standpoint of common sense and real military efficiency, it was not so simple from the standpoint of practical politics. A proposal to establish two or three really effective regiments in Connecticut, for example, might not look so good to the members of the twenty-two "paper" regiments then existing in that State. The twenty-two colonels, twenty-two lieutenant colonels, and twenty-two majors of these regiments were all proud of their uniforms, and they all owed their offices to the fact that they were political leaders in their several counties. In fact, if you stop to think of it, this "paper" militia had the makings of a very effective political machine, for every able-bodied voter in the state was necessarily a member of it, and most of the older voters had graduated from it.

Washington apparently appreciated that this subject was loaded with political dynamite, for he presented it with considerable tact:

"It may be laid down as a primary position, and the basis of our system, that every citizen who enjoys the protection of a free government owes not only a portion of his property, but even of his personal services, to the defense of it [italics supplied] and consequently that the citizens of America (with a few legal and official exceptions) from 18 to 50 years of age should be borne on the militia rolls . . . but as it is obvious, amongst such a multitude of people (who may indeed be useful for temporary service) there must be a great number who from domestic circumstances, bodily defects, natural awkwardness, or disinclination, can never acquire the habits of soldiers but on the contrary will injure the appearance of any body of troops to which they are attached, and as there are a sufficient proportion of able-bodied young men, between the age of 18 and 25, who, from a natural fondness for military parade (which passion is almost ever prevalent at that period of life), might easily be enlisted or drafted to form a corps in every state capable of resisting any sudden impression which might be attempted by a foreign enemy, while the remainder of the national forces would have time to assemble and make preparations for the field, I would wish therefore that the former (that is, the general body of the militia), being considered as the *dernier ressort*, reserved for some great occasion, a judicious system might be adopted for forming and placing the latter (that is, a sufficient portion of the younger men) on the best possible establishment. And that, while the men of this description shall be viewed as the van and flower of the American forces, ever ready for action and zealous to be employed whenever it may become necessary in the service of their country, they should meet with such exemptions, privileges, or distinctions as might tend to keep alive a true military pride, a nice sense of honor, and a patriotic regard for the public. Such sentiments, indeed, ought to be instilled into our youth with their earliest years, to be cherished and inculcated as frequently and forcibly as possible."

Washington's plan, outlined above, was that of the practical soldier and statesman. Its essential principle was to pro-

vide a regular army to take care of our peacetime military needs and to depend in an emergency on a well-organized and well-trained citizen army, available for call immediately, rather than upon an expansion of the professional forces.

On January 21, 1790, President Washington submitted to Congress a version of his original plan based upon universal military training. This plan was prepared by Brig. Gen. Henry Knox, Secretary of War, and was revised by the President himself. The First Congress adjourned without action upon these recommendations. In the Second Congress, Col. Jeremiah Wadsworth, a representative from Connecticut, introduced, on November 21, 1791, a bill (H.R. 148) giving effect to Washington's basic principle. This bill was taken up by the House on March 5, 1792.

IN lieu of the plan submitted, Congress passed what was known officially as the "Militia Act of May 8, 1792." Although this was signed by the President on that date, it was in direct contradiction to his basic principle. It contained no provision for universal military training which was the essential element of the Knox Plan. Washington finally approved it probably because he was reluctant to use the veto power and probably because he hoped for more constructive legislation later.

His reaction to his defeat is not known, but Madison's record of a conversation with him three days before he signed the Militia Act may be significant. According to this record, Washington informed Madison "that the fatigues and disagreeableness of his situation were in fact scarcely tolerable to him, that he only uttered his real sentiments when he declared that his inclination would lead him rather to go to his farm, take his spade in his hand, and work for his bread, than remain in his present situation."

That Washington's military policy failed to find favor in Congress was due to several causes. In the first place, as Madison wrote to Jefferson, the Knox plan was "long and imperfectly understood." But this was not its principal handicap, for Knox was as deficient in political tact as in literary skill. He pointed out that his plan was designed to defend the United States from *internal* as well as external enemies. In another place he indicated that "the Government should possess a strong corrective arm." This view was a little too strong for the times. Just then most of the people were inclined to think that the new government was already overendowed with coercive power. At a time when they were appending a "Bill of Rights" to the new Constitution of the United States, they were not inclined to equip the Federal Government with "a strong corrective arm."

In February, Benjamin Lincoln wrote to Knox: "Though it would make ours the strongest militia in the world, the people will not adopt it here if I know Massachusetts. . . . The expense . . . the burden on masters, calling the youth indiscriminately . . . will be magnified here and damn the bill."

Nor did the existing militia organization take kindly to the Knox plan for a scientific regimentation of the national man power. In a contemporary number of the *Gazette of the United States* there is a letter from a correspondent in Hartford:

"By the returns of the Militia of the State of Connecticut, there appear to be 6 brigades, 13 regiments of infantry, 6 of cavalry . . . amounting in the whole to 30,000 effective men, well officered and appointed, and completely armed. Most of the regiments were reviewed last month, and are generally in a neat uniform. A degree of emulation pervades officers and privates to excel in the military art that does honor to them as freemen and as citizens of a republic who are determined to support the Constitution and government of the country without the aid of a standing army *or an expensive national militia . . .*"

If the State of Connecticut with a population of only 235,000 could mobilize an effective army of 30,000 men, there would seem to be little need for reform—at least in that State. But she was not alone in her military might. An item from Boston in another number of the same paper shows that the official returns of Massachusetts for 1790 gave that State 9 infantry divisions, 19 infantry brigades, 73 regiments of infantry, 29 troops of cavalry, 254 corps of artillery, and other miscellaneous organizations.

One other newspaper item (from the *Pennsylvania Packet and Advertiser,* April 20, 1790) will suffice to show the popular attitude toward the Knox plan:

"Elizabethtown, April 14, 1790.—The plan for the organization of the militia of the United States by the Secretary of War is generally execrated in this State, as pregnant with mischief both to the agricultural and mining interests as well as having a tendency to debauch the morals of the rising generation."

IT will be seen from the foregoing that our forefathers rejected a sound national military policy at the very beginning of our country's life. That policy was based upon the democratic principle that, in his youth, every citizen of a free state should be trained to defend his country. Washington's plan of 1790 included simple and economical machinery for the orderly and progressive mobilization of all or any necessary part of the Nation's military man power. If it had been established then, and its training requirements, organization, and equipment gradually adapted to meet changes in population, weapons, and modes of transportation, it would have prepared us for every military emergency in our subsequent history. In fact, to use Washington's language, it would have made us so "respectable in the eyes of our friends" and so "formidable to those who would otherwise become our enemies" that most of our wars would not have occurred.

At first glance it might appear that when our forefathers rejected Washington's military policy they simply decided not to have any military policy at all. But that is not the lesson of our subsequent history. In rejecting Washington's sound policy they automatically adopted an unsound policy. We have had several wars since 1790 and in all of them it has been our *actual* military policy to extemporize our war organization after the imminence of the emergency. That is the most absurd military policy that any nation ever adopted.

If we are to have a sound organization after the present war it must rest upon the same foundation that Washington proposed to the First Congress—compulsory military training for every able-bodied young American.

Editor's Note.—The essential soundness of Washington's basic conception of organization is well illustrated by his letter to the Secretary of War, General Knox, dated September 24, 1794, and quoted by General Palmer in his "Washington, Lincoln, Wilson": "My observation on every employment of life is, that whatever and whenever one person is found adequate to the discharge of a duty by close application thereto, it is worse executed by two persons, and scarcely done at all if three or more are employed therein."

Small Arms Inspection

The Task of Insuring Quality Weapons and Ammunition

Lieut. Col. M. L. DeGuire

PROBABLY the most widely used and least understood weapons of this war are small arms. Practically every one has at some time or another in his life used a rifle, a pistol, or a shotgun for hunting or for target practice, or has seen a machine gun in action or pictures of airplanes in which they are mounted. Consequently, when the subject of small arms arises, the usual reaction of the average individual is that their manufacture is "child's play." Familiarity breeds contempt! A tank has glamour—it is novel, it is new. A rifle is old stuff. As one very high Government official expressed himself when examining a new weapon and its ammunition: "Why that little thing ought to be easy to make."

Small arms are little things, but the corollary assumption is quite erroneous. The linking together of the two thoughts is fallacious, for, if no other reason is considered, quantity alone makes small-arms production a giant in a world of giants. Machine guns by the hundred thousand, rifles by the million, and cartridges by the billion is a staggering total. What is a billion rounds of ammunition? It would require a hundred trains of sixty cars each to transport a billion rounds of caliber .50 ammunition!

"Little things . . ." The weapon so described was the new caliber .30 carbine. Intentionally, it is a tiny thing as shoulder weapons go, but that doesn't make it easy to produce. A carbine has sixty-one different parts, and the bolt alone requires fifty operations. Almost all the dimensions must be held within precision limits. Consequently, extreme accuracy in manufacture is necessary to insure that when the components are assembled the weapon will function and continue to function with a satisfactory life. These same conditions apply to all machine guns, pistols, rifles, and ammunition.

Careful inspection is a "must" in the acceptance of all small arms. Our Army, Navy, and Marine Corps, on the ground, on the sea, and in the air, are armed with weapons produced under the supervision of the Small Arms Branch of the Ordnance Industrial Division. Every round of ammunition for every rifle, pistol, and machine gun is produced under the jurisdiction of the Small Arms Branch. Small arms and small-arms ammunition make our combat troops the deadly fighters that they are. Small arms protect our battle fleet, our ground installations, our landing fields; they form a potent part of the armament of every tank and combat vehicle; and they constitute the personal offensive weapons of every individual soldier.

The most effective automatic weapon in use by any nation or any army in the war is the caliber .50 machine gun. Its efficiency is attested by the numbers of enemy planes that have been shot down, not only by our fighter planes but by our bombers on which it is the principal weapon of defense. A glimpse of the efficiency and complexity of this weapon can be gained when one considers that over 250 closely machined parts go into its construction and that when fired full automatic it develops 5.5 horsepower per pound of weight. If an automobile engine were quite as powerful, it would probably weigh in the neighborhood of fifteen pounds. The production of weapons and ammunition of this caliber requires the most careful control. Recognizing the necessity for maintaining the most rigid inspection to assure that nothing but the best gets into the hands of troops, the Small Arms Branch has attempted to organize inspection toward this goal.

The caliber .50 aircraft machine gun weighs approximately 62 pounds and is capable of firing at a rate of over 800 rounds a minute. It is manufactured as a basic gun, and components are procured which permit it to be installed in either a fixed or a flexible mounting. It feeds from either side. As the receiver of the caliber .50 gun is common to all caliber .50 types, the aircraft gun is convertible to the heavy-barrel type or the water-cooled gun. The heavy-barrel caliber .50 is used in tanks and as an antitank weapon. The water-cooled gun is primarily an antiaircraft weapon.

The caliber .30 aircraft machine gun has been largely relegated to the status of a training weapon in this war. The superior striking power of the caliber .50 has caused the caliber .30 to become obsolescent for air combat. It is patterned after the caliber .50, weighs about 21 pounds, and feeds from either side. Its cyclic rate is over 1,200 rounds a minute.

ALL machine guns that are standard are based on the Browning design which is exemplified in the oldest of the standard guns. The M1917A1 is a water-cooled machine gun that weighs approximately 32 pounds; it has only left-hand feed and a rate of fire of approximately 500 rounds a minute. It is used primarily as an infantry weapon.

Offshoots of the M1917A1 are the M1919A4, A5, and A6, each an air-cooled gun with the same receiver and action as the parent gun. The A4 has a heavier barrel, an air-cooled jacket, and a new sight. It is used as an infantry and cavalry weapon, and is also used in tanks. The A5 has certain modifications for special tank usage. The A6 has a bipod, lighter barrel and stock, and is used as a light machine gun by the infantry. Here again a basic receiver and common parts simplify the problem of supply and maintenance. The Infantry, the Cavalry, the Engineers, and the Armored Force all use the same basic gun.

The submachine gun has long been known as the "Tommy gun," from the name of the inventor of the first standard submachine gun, the Thompson. The 1928A1 is a prototype of the M1; both weigh approximately 11 pounds. The new M3 which replaces the older "Tommy gun" weighs only 8.5 pounds; it is quite novel in that the receiver is fabricated from two welded stampings.

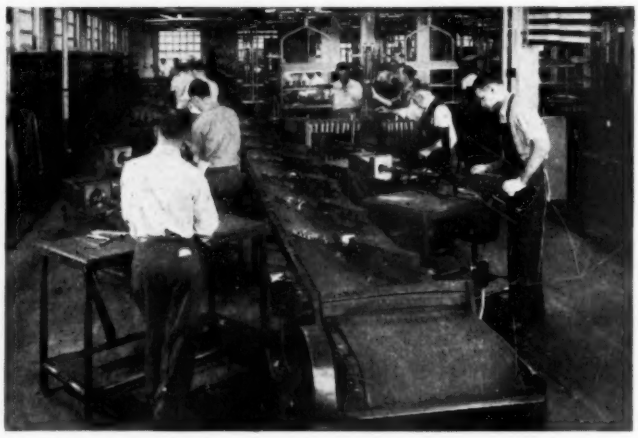
The last of the true automatic weapons in small arms is the Browning automatic rifle, M1918A2. It is also the only standard gas-operated fully automatic weapon in the service. Equipped with bipod, it weighs twenty pounds. This weapon is proving its worth daily in the South Pacific, according to reports from that theater.

As weapons are useless without accessory matériel, the Small Arms Branch is also faced with the problem of accepting all ammunition chests, mounts, tools, cleaning rods, and

Colonel DeGuire is executive assistant to the chief of the Small Arms Branch, Ordnance Industrial Division.

related equipment produced under the Army supply program. The multitudinous variety of these items presents an intricate problem in inspection. Mounts are a big business in themselves. They include the 1917A1 to match the 1917A1 gun, the M2 tripod for the 1919A4 gun, the M3 tripod for the caliber .50 heavy-barrel gun, and the M2AA, M2A1, and M2 for the caliber .50 heavy-barrel or water-cooled gun for antiaircraft use.

The latest comer to the semiautomatic field is the caliber .30 carbine. In the summer of 1940, it was only an idea expressed to all known gun designers and manufacturers. In October of 1941, tests were conducted to select the most satisfactory of the guns presented. In June of 1942, the first production carbines trickled from the line. The maximum monthly rate of production in the fall of 1943 was more than double any known rate ever before attained in the production of a shoulder weapon. The carbine is a gas-operated weapon for paratroopers, supply forces, and officers. It does not replace, but augments the rifle and pistol. It is novel in that the gas is withdrawn at a point near the chamber instead of near the muzzle, so that in reality the weapon is gas-actuated. The impact of the gas on a short-stroke piston drives the operating slide to the rear, ejecting the empty case. The carbine weighs approximately 5 pounds, can fire 15 rounds without reloading, and is effective up to 300 yards.



INSPECTION OF ASSEMBLED MACHINE GUNS

One of the deadliest shoulder weapons ever developed or put into the hands of a fighting man is the caliber .30, M1, rifle, widely known as the Garand. It weighs approximately 9 pounds, is gas-operated, and can fire 8 rounds without reloading.

The oldest rifle being procured for this war is the famous M1903 or Springfield rifle. It still retains its popularity and is the only rifle fitted with a telescope for sniping. It is a bolt-action, manually operated rifle weighing approximately 9 pounds.

The second oldest semiautomatic arm being produced in this war is the caliber .45, M1911A1 pistol. It is a recoil-operated weapon, weighing approximately 39 ounces. It has never been an extremely popular weapon because of the skill required for accurate firing. It is welcomed by troops in the jungle for close-in fighting where it has the same deadly effect it had on the Moros in the early days of the Philippines.

Among the other weapons and equipment procured by the Small Arms Branch are four types of shotguns, caliber .22 rifles, machine-gun trainers, bayonets, trench knives, three types of helmets, pyrotechnic projectors, and pistols, revolvers, grenade launchers, hand carts, metallic belt links, and all tools, cleaning material, and accessories.

The Small Arms Branch is also responsible for the procurement, production, inspection, and acceptance of all small-arms ammunition. This is a unique arrangement, but it has been particularly advantageous in that it permits the closest coördination of ammunition production with gun production. It also insures that the rounds will always work in the weapon, for one man—the chief of the Small Arms Branch—is responsible for both.

Small-arms ammunition can be divided into three basic classes: aircraft, rifle and machine-gun, and training ammunition. Aircraft ammunition is a superior grade of calibers .30 and .50. It is inspected and accepted under the most rigid standards. No blemish or mark is permitted that might even have a remote possibility of causing a malfunction while in use in the air. A ground gunner has a chance; a gunner in a plane might not.

Rifle and machine-gun ammunition include calibers .30, .303, .38, .45, .50, and 9-mm. Calibers .30 and .50 ammunition is made in the following types: ball, high-pressure, tracer, and incendiary. Calibers .45, .303, .38, and 9-mm. are made only in ball. Training ammunition includes caliber .22, shot shell (for skeet and trap), dummies, and blanks. Shot shell is manufactured in riot or "buckshot" and light skeet loads. In small-arms matériel, the inspector never gets stale for lack of variety of product!

Any exposition of small-arms inspection would be incomplete without an explanation of the Small Arms Branch of the Ordnance Industrial Division, its operations, and its relation to the Ordnance districts.

THE Small Arms Branch is organized on a commodity basis. There are four main operating sections—hand-arms, machine-gun, rifle, and ammunition. These four sections are charged with the responsibility of procurement, production, engineering, and inspection of material assigned to them. Each of these sections is in itself a complete unit, so organized that it could operate independently of the other. Each section chief is responsible for all the functions assigned to his section.

With a commodity organization, it is necessary to have a limited amount of staff control to insure that the same principles are applied in the same way in each section, so that in the Small Arms Branch there are a planning and scheduling section, an administration section, an inspection section, and an engineering section. These staff sections coördinate and assist the operating sections.

As this article deals primarily with the operations of inspection in the Small Arms Branch, we shall limit discussion to the operation of the four commodity sections and the relationship of the inspection section to these sections. The inspection section is a very small group which has been trained in all principles of inspection of small-arms matériel. It is their responsibility to insure that proper procedures and the same policies are followed with regard to inspection of all matériel. This group is available on call to the operating sections for the solution of difficult problems and to render advice to the districts and the Government-owned contractor-operated plants. The four commodity sections are charged with the job of carrying out and supervising the inspection of small arms.

Obviously it is impossible to centralize in Washington the operations of carrying out a project as immense as the inspec-

tion of small arms. With the exception of the small-arms ammunition plants, which are Government-owned and contractor-operated, and the Government arsenals manufacturing small arms, all inspection of small-arms matériel is conducted by the thirteen Ordnance districts. With thirteen districts and as many as ten plants producing exactly the same weapon scattered through the districts, the interpretations of prescribed methods become tremendous.

THE problem, then, resolves itself into one of supervising and coördinating the operations of the Ordnance districts charged with the administration of the contracts. The districts are the backbone of the system, and it is only through their conscientious, tireless activity that the system works. All dealings with contractors are through the district to the Army inspector of ordnance in the plant. The short-circuiting of this channel is taboo. If a manufacturer does short-circuit his Army inspector of ordnance and district, he seldom gets an answer from Washington. An answer is given by his district and through the plant inspector. Violation of this rule weakens the position of the Army inspector of ordnance and invariably causes confusion. If the districts and plants can be kept coördinated so that the procedures and standards are uniform, and if these standards are kept correlated with field and performance requirements, our objective is readily met. It is the responsibility of the operating sections to establish standards, coördinate them, and keep them correlated with field demands.

U. S. RIFLE, CALIBER .30, M1—THE GARAND

Weight: 9 lbs., 10 oz. *Length:* 43 9/16 in. *Clip capacity:* 8 rds. *Action:* semiautomatic. *Maximum range, standard cartridge:* 3,450 yds.

The Small Arms Branch operates no proving ground for the acceptance of the matériel manufactured. At each facility manufacturing small arms, there is a resident inspector. In some of the larger plants this inspector is an officer; in other plants he is a key civilian employee who has been trained either at one of the arsenals or in a training course established by the district in a plant producing similar items. Upon the shoulders of the resident inspector falls the burden of work. He is the true operator and the cornerstone of the structure of small-arms inspection. He is the contractor's contact with the Ordnance Department on all inspection matters and the Ordnance representative through whom all requests for improvements are transmitted. He is always in the "middle." This method of controlling operations has advantages and disadvantages, with the advantages far outweighing the disadvantages. The resident inspector is in a position to analyze difficulties immediately, and the manufacturer is in a position to make positive and rapid corrections to eliminate the difficulties. It also means that when matériel is accepted and shipped from the plant, it is immediately available for issue to troops for combat.

What is the objective of inspection? To assure the acceptance of satisfactory ordnance matériel. Too many people have the idea that the purpose of inspection is to reject. Nothing can be further from the truth. Rejections are necessary, but acceptance is even more important and necessary if a successful war is to be fought. Corollaries to our objective are system and speed so that the maximum amount of satisfactory matériel may be accepted with a minimum delay and with the minimum number of people required for the job. To carry out an operation to meet this objective requires alert planning and foresight, for without planning, inspection soon becomes a hit-or-miss proposition. Not only must the planning cover what must be done, it must cover how this inspection can be done. Details, which at first blush appear very inconsequential, must be covered; otherwise every plant manufacturing the same item will go their diverse ways, and soon this divergence will find its way into the major details.

Once an item fulfills the requirements of the military characteristics established by the using services and is standardized by action of the Ordnance Committee, preparation for manufacture starts immediately. The first step is the preparation of the necessary engineering drawings for the item. This requires a study of the development item by both Ordnance and production engineers and the placing, in concrete form, of all the necessary dimensions, the materials of which the components are to be made, finishes, physical properties, and prescribed heat treatment. As many of the physical attributes of the weapons cannot be seen on the drawings, specifications are prepared concurrently which outline these requirements. As the item was standardized to meet certain specific military characteristics, special performance tests become a part of the specification to insure that the weapon as manufactured meets these characteristics. These tests usually take the form of function-firing tests, endurance tests, interchangeability tests, and targeting and accuracy tests. The specifications also include instructions on shipping.

AS soon as the necessary engineering drawings are prepared, they are furnished to the gage section for review and recommendation so that the necessary gages will be designed and will be available when the weapon does go into production. The gages that the Ordnance Department uses to inspect at a manufacturing establishment are final-inspection gages as differentiated from process gages. With the exception of our Government manufacturing arsenals, where work in process of necessity must be carefully checked, the Ordnance Department does not inspect work in process, but depends entirely upon the contractors.

Small-arms inspection is limited to the inspection of completed parts and completed assemblies. This policy eliminated much duplication of effort and resulted in the savings of thousands of man-hours and millions of dollars. It was not arrived at without much trial and error and many changes in operating procedure. The reasons underlying this mode of operation are covered later, but the principal one is that it brings home to the contractor the necessity for the closest control and supervision of his own methods and processes.

Of particular interest are the strides that have been made in the use of gages during the present emergency. The greater

bulk of our gages at the start of the war were mechanical. Greater and greater emphasis has been placed upon the so-called dial-indicator type of gage and on the use of comparators. The comparator is being adapted to many uses and has increased the speed and accuracy of our gaging tremendously. The drawings and the specifications establish for our inspectors the "what" of our inspection, and, as part of the contract, the drawings and the specifications are the determining factors in the acceptability of matériel. The gages are tools which enable the inspector to decide if the requirements of the drawings and the specifications are met. The gage section of the Ordnance Department has done a remarkable job in adapting new methods and new gages to small-arms matériel. In the carbine program alone, $2,000,000 worth of gages were designed, procured, inspected, and maintained by the gage section and its district and suboffices.

U. S. CARBINE, CALIBER .30, M1

Weight: 5.23 lbs. *Length:* 35.5 in. *Magazine capacity:* 15 rds. *Action:* semiautomatic. *Effective range:* about 300 yds.

The Small Arms Branch has insisted that facilities be organized at each manufacturing establishment for the inspection and testing of the matériel produced under the contract. This policy has been adhered to at all the Government-owned contractor-operated ammunition plants and in all the private facilities producing matériel under prime contracts in the districts. The question has been asked why it would not be practicable to establish one or more proving grounds for this purpose, thus eliminating a duplication of organization.

THERE are three principal reasons for this method of operation. First, it gives the inspector complete control over the quality of the matériel manufactured at the plant. Therefore, there is no time lag between completion of the item and testing to determine its acceptability. If difficulty is encountered, it permits the manufacturer to take immediate, positive, corrective action to eliminate the fault, and it permits him to change his manufacturing processes to remove the difficulty in future production. Further, as the matériel is accepted at the plant, it immediately becomes available for shipment to troops and thus eliminates the possibility of transshipment from manufacturer to proving ground to troops, or from manufacturer to proving ground back to manufacturer for correction.

The next main reason for the establishment of test facilities at each manufacturing plant is that the usual volume of production at each plant is sufficient to justify the establishment of a small proving ground right at the facility. Up to and including the present time, the proof facilities are utilized to maximum capacity so that there is no duplication or waste. Experience has shown that it is comparatively easy to construct ranges to do this testing. Further, the cost of the installation is nominal and is soon offset by the savings in transportation which accrue.

The third reason is that the testing at the manufacturers' plants has brought to light many difficulties which were directly traceable to faulty design or to interferences between mating components. If the testing had been done at a proving ground, all the difficulties would have been attributed to faulty manufacture and a great deal of time would have been lost in tracing and locating the true source of trouble. As for duplication of personnel, it is the opinion of the Small Arms Branch that no more people are required to conduct inspection and acceptance testing at the plant than would be required at a proving ground. The efficiency obtained by this type of operation more than justified the expectations. An organization would have to be established in the plant to conduct the necessary inspection of components and major items prior to shipment to a proving ground. This organization would require inspectors, gage control, and gage checkers. Under the present system, by extending the operations slightly and by utilizing the existing overhead, the inspection force can adequately conduct the necessary ballistic and acceptance testing ordinarily done at a proving ground.

USUALLY, the maximum time interval between the manufacture and acceptance of completed guns and ammunition under the above plan is less than twenty-four hours. The branch has insisted that adequate inspection forces be available so that in no case is production held up by Government inspection. Early in the war effort the question of when to inspect was bitterly argued by proponents of two different schools of thought. The first argued that if component inspection was adequate and that if every component met all the requirements of all the drawings and specifications, then the final weapon of necessity had to be satisfactory. The second school of thought argued that Government control of process inspection and Government component inspection are unnecessary and a duplication of effort, and that inspection should concentrate only on the finished item.

There are arguments which favor both sides. As a result, inspection as practiced in the small-arms industry today is a combination method. Stress is placed on the inspection of the completed item and on the determination of whether the item will function, continue to function, and interchange. In determining the last of these characteristics, it is necessary to do a certain amount of inspection of components and to conduct interchangeability tests upon completed items. The amount of component inspection is usually limited to those components which are destined to be spare parts. These components are selected at random from lots which have been presented as being satisfactory for assembly into completed guns. The quantities selected are ordinarily based on the statistical sampling plan of inspection as used by the Ordnance Department in quality control.

If the selected sample meets the requirements of the established quality level, the inspected components are placed in spare parts and the balance of the components are released for assembly into completed weapons. Upon completion of assembly, each weapon is function-fired and checked for reliability and completeness. No weapon is released into the hands of troops until it has been subjected to a high-pressure

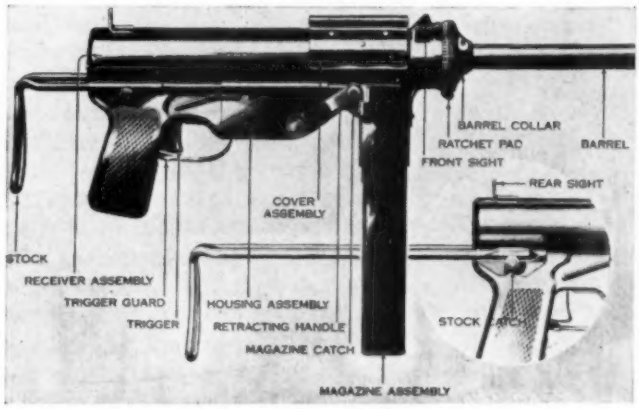
proof round and to the functioning test which varies from 20 rounds to 200 rounds, depending upon the type of weapon.

Similarly, ammunition is presented in lots by the contractor for acceptance by the Government. Samples based on the statistical sampling plan of quality control are selected at random from the lot and gaged for compliance with drawings.

As a cartridge can be dimensionally perfect and still be useless, functioning and ballistic tests are a very necessary part of acceptance inspection. Samples are checked for pressure and velocity when both wet and dry. In addition, the ammunition is check-fired in each weapon in which it is to be employed in the field.

Full reliance is not placed on the final round, however. Processes are checked, and components are gaged prior to assembly to insure they meet the requirements of the drawings and specifications. Primers are inspected and tested by the Government prior to assembly into the case.

Thus, in both weapons and ammunition, inspection concentrates on the finished weapon or spare part and the finished round and makes process and preassembly inspection secondary. Constant checks insure that the contractors' process inspection is not slighted either.



U. S. SUBMACHINE GUN, CALIBER .45, M3

Weight: 8 lbs., 15 oz. *Length closed:* 22½ in. *Magazine capacity:* 30 rds. *Action:* straight blowback. *Cyclic rate:* 450 r.p.m. *Effective range:* 300 yds.

Perhaps the most important factor in the effectiveness of an inspection plan is the "how." When the huge procurement program first got under way, this office prescribed the "what," "where," and "when" of inspection with contracts, drawings, specifications, and inspection manuals. It soon became apparent that this was not sufficient and that it was necessary to prescribe the "how." The basic guide in all small-arms inspection is the General Inspection Manual. As its name implies, it furnishes broad plans and a general guide for the inspection of ordnance matériel. Special inspection manuals have been prepared for practically every item of small-arms matériel.

With the number of plants producing the same items and with continually changing inspection personnel, interpretations of instructions in the manuals become a most serious problem. In order to clarify this situation, the Small Arms Branch initiated a series of pamphlets which outlined general plans and policies for the inspection of each major item of small-arms matériel. These plan-and-policy pamphlets have served two purposes. The first was to outline an operational plan which was suitable for application at each plant manufacturing the item. Realizing these general technical plans could not take into consideration the plant layout, personnel, or personalities, each district and each inspector at a Government-owned contractor-operated plant was requested to build specific plans of inspection on the foundation and framework of the general plan. This had the result of putting exactly the same procedure and method of operation into effect in each facility making the same item and assisted in eliminating complaints that one manufacturer had relatively lax inspection as compared with other manufacturers.

The second purpose of the plan-and-policy pamphlets was to clarify those points which were implied or required by the inspection manuals and the drawings and specifications. A few of the points which have needed clarification are the inspection of raw materials, the amount of component inspection, the amount of final inspection, and the handling of salvage or waiver material. While it is not possible in a paper of this kind to cover each of these points, a review of one of them should demonstrate the steps that have been taken to clarify and make uniform the handling of troublesome problems.

Salvage material is defined as that material which deviates from the drawings and specifications in any respect. Even under well-controlled manufacture, a small percentage of material is made which does deviate from the drawings. Some of this material is usable and some of it cannot be used without affecting reliability, interchangeability, or usable life. By the establishment of salvage cribs for the segregation of substandard material prior to presentation to the Government, the Government is assured that the bulk of the material presented is in strict accord with drawings and specifications. The contractor also is assured that the material which is placed in salvage will receive due consideration by personnel qualified to judge whether the material is usable or is scrap. The salvage crib serves also to remove questionable material from the lines as it is discovered so that undue time is not lost in processing it and so that it does not slow up the flow of components of good manufacture. The segregation of this material also eliminates the exercising of judgment by personnel who are not qualified to exercise judgment. When material which deviates from the drawings is accepted, this acceptance is in writing which serves to make it a matter of record.

IT would appear that after the "what," "when," "where," and "how" of inspection is established, the problem is solved. However, without coördination and continued efforts to improve, each facility soon establishes its own method and interpretation of standards to fit its immediate problems and conditions. Keeping the various facilities coördinated, fully informed, and maintaining uniform standards is considered to be the biggest part of a proper solution to the inspection problem. One of the most effective methods used by the Small Arms Branch is the Inspection Council. This council is composed of the chief Ordnance inspector of each facility manufacturing an item, qualified representatives of the district in which the facilities are located, representatives of the Small Arms Branch, and the key inspector for the integration committee for the industry concerned. The Inspection Council meets at regular intervals for the purpose of giving each inspector the opportunity of discussing his problems with the other inspectors. As the council meetings are usually held at a facility manufacturing the item, it gives each inspector an opportunity to observe the methods and procedures in effect

in a facility other than his own and thus broadens his outlook and stimulates his approach to his own problems.

As mentioned above, industry integration committees have been formed for some of the major items of small-arms matériel. To these committees there have been assigned the best qualified inspectors in the industry to act as key inspectors. It is their responsibility to review procedures, standards of interpretations and drawings, standards of finish, and the use of gages. They are limited, however, to inspection problems within limits of the drawings and specifications. The key inspectors have been of material assistance in this problem of coördination and act as representatives of the Office of the Chief of Ordnance.

Spot checks are made on the effectiveness of the procedures established by representatives of the operating sections and the inspection section. These checks further assist in the problem of coordination.

In order to obtain confirmation on the concrete performance of material produced at a facility, tests are conducted on small samples selected at random from that which is shipped to Field Service stores. These tests are conducted at Aberdeen Proving Ground by personnel under the jurisdiction of the Ordnance Technical Division. As a further check, interplant interchangeability tests are conducted. Guns from each manufacturer are completely disassembled, parts are mixed, and guns are reassembled by selecting components at random for assembly. These interchanged guns are then subjected to all the function and acceptance testing required of the original guns. These tests prove the effectiveness of the gaging system and assure that components of one firm's manufacture will assemble into guns of another company's manufacture.

Periodically, samples of ammunition from each ammunition plant are sent to Frankford Arsenal where acceptance tests are repeated to determine the efficiency and quality level of the various facilities.

THE preceding summary of the checks and balances used in the inspection of all small-arms matériel and ammunition presents a picture of the organization and methods used to obtain acceptable material. The reader very properly may ask "whether this operation has been effective." Without the slightest equivocation, the answer must be "Yes." It cannot be claimed that the system or the inspection has been perfect. In any program as complex and as large as the inspection program for small arms, mistakes do occur. Poor judgment is sometimes exercised. Operating personnel do at times fail to recognize all phases of the problem surrounding the use of the material. However, a very small percentage of matériel has been accepted which should have been rejected.

Energetic action has been instituted in the few cases where matériel which could be classed as unsatisfactory has been shipped to the field. The lessons learned at one facility are made available to all other manufacturers of the same matériel so that, as far as the records indicate, not once has the same mistake been duplicated at facilities.

Close-working relationship between the Maintenance Branch of the Ordnance Field Service Division and the Industrial Division and the furnishing of prompt accurate information from the field on erratic functioning has done much to improve the operation of the inspection organization. The reports of field observers and the "Products Correction Reports" have not only served to modify the inspection of specific items but have served to modify the entire approach to the inspection problem.

Since the inception of the present war program, billions of rounds of small-arms ammunition have been inspected and accepted. While figures on expenditures of ammunition in combat and in training are not readily available, it is known that the Air Corps has fired over 40,000,000 rounds in combat alone. The reports of difficulty on ammunition are practically nonexistent. Millions of rifles, submachine guns, machine guns, and carbines have been manufactured, inspected, and sent to the using services.

If the reports that are received from the South Pacific, Alaska, Africa, and Italy are not biased, the quality of the weapons is phenomenal. In a single air action in North Africa our combat pilots fired 25,000 rounds of caliber .50 ammunition without a single malfunction attributable either to the gun or the ammunition. In this action, seventy German transport planes were destroyed. Similar reports are being received constantly which testify that the plan of inspection used for small-arms matériel and ammunition is adequate and that the operation of inspection is definitely satisfactory. On this page is a letter from the Office of the Chief of Air Forces to the Chief of Ordnance, which in itself is the greatest praise obtainable for the effectiveness and efficiency of small-arms inspection.

WAR DEPARTMENT
Headquarters of the Army Air Forces
Washington, D. C.
27 November 1943

Subject: Commendation
To: The Chief of Ordnance, The Pentagon, Washington, D. C.
Thru: The Commanding General, Army Service Forces, The Pentagon, Washington, D. C.

1. The Commanding General of the Army Air Forces, with the full realization of the many outstanding achievements of the Ordnance Department in developing and producing large quantities of outstanding equipment for the United States Forces, wishes to commend specifically the Ordnance Department of the Army Service Forces for the magnificent achievement in furnishing the Army Air Forces with the most outstanding aircraft gun of World War II; namely, the caliber .50 aircraft machine gun.

2. This weapon, together with its ammunition, is the backbone of offensive and defensive guns for American aircraft and was brought to such a state of perfection by the Ordnance Department during the years of peace prior to the present conflict that it has enabled the Army Air Forces, the United States Navy, and Marine Corps to show a definite superiority in aircraft gun power throughout this global war.

3. The Commanding General, Army Air Forces, recommends that the Chief of Ordnance take such steps as he deems appropriate to extend suitable recognition to those individuals and organizations responsible for the development and production of this weapon.

For the Commanding General:

BARNEY M. GILES
Major General, U. S. Army
Chief of the Air Staff

EDITOR'S NOTE.—G. Rupert Gause, writing on "Quality through Inspection" in the July-August 1943 issue of ARMY ORDNANCE, stated: "An important part of any quality-control plan is a provision calling for the recording of certain results and the routine summarizing and use of these results. The plan will indicate which results are worth while recording and which are not, and also show how the results are to be summarized."

Apprentice Training

Watervliet Arsenal's Program for Developing Skilled Machinists

E. S. Webster

APPRENTICES have been trained from time immemorial. Early historians record the use of apprentices in the building of King Solomon's Temple. The aim today is, as it was then, to develop skilled craftsmen. Checks of key men, leaders, and foremen in industry disclose a great percentage who have made their start as apprentices. This holds true for Watervliet Arsenal where apprentice classes have been trained intermittently since around 1900.

Forward-looking industries today view an apprentice not only as a potential skilled craftsman but as a potential leader or foreman, selected with that end in view, and they incorporate features in their training programs calculated to provide for developing the man for higher responsibilities. Programs and policies differ in various plants according to their kind of product, their size, age, viewpoint, localities, labor conditions, etc.

Regrettably, the spirit of apprenticeship has in some cases been violated in the quest for cheap labor, but this misuse may have been responsible for positive results by focusing the attention of Government agencies on apprenticeship training. This interest is now shown by various state regulations covering apprenticeship. The Federal Board for Vocational Education is given credit for its work in coöperation with several state and local boards toward the promotion and development of vocational training in industry and public schools. The Federal Committee on Apprenticeship of the War Manpower Commission is also assisting industry throughout the country.

In 1931, an exhaustive study of apprentice training in 160 manufacturing concerns of the metal trades was conducted by the University of Akron in coöperation with the Ohio State Board for Vocational Education to ascertain what industry had been doing along this line in the previous ten years. Information was compiled as to what trades were taught, the entrance qualifications for and testing of applicants, qualifications of supervisors and instructors, training department organizations, programs, policies, etc., which was very helpful as a guide in building up the training organization at Watervliet Arsenal.

Unfortunately, during the depression many industries discontinued their training programs for reasons of economy, and training was also discontinued at this arsenal. In 1939, when the war clouds were darkening over Europe, thoughts again turned to industrial training. In the War Department arsenals, existing training programs were expanded and new ones were initiated where none were in existence before. After the war in Europe started, the tempo increased because, as the commanding officer of Watervliet remarked, "The bell may ring for us one of these days; we have a big job to do and we must be prepared."

There was little local background to draw on as the program envisaged was greater than any previously conducted at this arsenal. Since little time remained to orient such a program and since industry and training techniques had advanced greatly, in order to build on as firm a foundation as possible the arsenal first looked to existing and successful training departments for ideas. Some of these techniques were adopted and some were modified to fit local conditions.

As with most plants, Watervliet manufactured a specialty —"cannon." This is a commodity either not wanted at all or wanted in great quantities and at once. During peacetime, the art of cannon manufacture has been perpetuated and developed at this arsenal. The boys taken on now who stay with the arsenal will be the ones to carry on this job. There are many tricks to the trade, and it is important to assign the boys so that they learn as many of them as possible during their trade training.

The University of Akron's study of 160 plants revealed that training was given in 28 different occupational classifications and that 144 of the plants included machine-shop instruction. The Boston Navy Yard, for example, gave training in twenty-two different trades. Watervliet's program, being confined to apprentice machinists, with an occasional heat-treater apprentice, permitted a more compact and integrated organization than if more trades required consideration.

MANY plants have educational requirements such as completion of the tenth grade for some courses; some require high-school graduation. In some cases boys whose parents are employed are favored; in others, recommendations by employees or reputable citizens are considered. A trend is developing to require the satisfactory completion of a technical high school course as a major qualification.

Eligible ages generally range from 16 to 20, with preference toward both extremes by differing plants. Watervliet's first class of boys in 1939 was in the older brackets, some being 21 years old. They had just lived through the depression and the jobs were attractive to them. During our organization, great demands were made on their self-reliance, resourcefulness, and dependability. They appreciated the value of their training, were mostly interested in learning, advanced rapidly, and were fine students generally. True, some became interested in marriage, became involved in financial difficulties, and cast glances at better-paying jobs. But only a few passed up their apprenticeship for such jobs lacking future opportunities.

At the other extreme, Watervliet's last classes of boys were 16 years old, selected from a more limited list of eligibles and at a time of greater employment opportunities. About fifty per cent developed into desirable material. Considerable disciplinary action and some separations were necessary to bring them into line, and it was necessary to start class work at a lower level and apply more pressure to obtain results. During normal times, 17 and 18 years would be considered as desirable ages.

Many plants include general intelligence and aptitude tests such as the Stenquist, Otis, Minnesota, etc., or tests of their own devising. Watervliet is interested in a boy's ambition and determination, willingness and ability to learn, courtesy and character. A mechanical or vocational background is

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desirable, if he possesses other satisfactory traits, but cannot be given too much weight alone. Some schools, unfortunately, have made a practice of feeding backward students into vocational classes, and they do not make the best material. Many of our boys who completed their course with highest ratings showed the least promise from the standpoint of previous vocational background but rated high in the Civil Service test and in personality and character traits.

Civil Service rules do not prescribe any educational background but do require a passing grade in a competitive examination which tests for general intelligence, observation of common tool pictures, analysis of block and force diagrams, and mathematics as applied to practical problems along mechanical lines. This test provides a very good indication of desirable mental qualifications. The application form also lists personal data, information on past employment, and the names of five references. When considering boys for employment at Watervliet Arsenal, data is obtained from schools as to scholastic attainments, extracurricular activities, and character, personality, and social attributes. After scrutiny of these records, the boy is called in for interview by a selection board consisting of the officer in charge, the academic instruction supervisor, and the department foreman for final selection or rejection. Selections are made on the basis of unanimous agreement. Evidence of mechanical aptitude or previous vocational training play a large part in influencing selection. After selection, the applicant is required to satisfactorily pass the required physical examination.

With the necessarily rapid expansion of war industries, great strides have been made in the development of aptitude and other entrance tests which would bear study with a view to application in the testing of apprentice candidates in the future.

THE supervisor is the spark plug and flywheel of the whole outfit. It is truly said, "An organization reflects its head." What he is and does will be reflected in the program and its results. It is desirable that he possess a good familiarity with the work in the shops, trade knowledge if possible, the workings of the plant organization, and the good will of the plant foremen with whom he must deal. This latter can make or break him and his program. Factors which will make for his success are honesty and a sense of fair play, tact, imagination, initiative, energy, ability to maintain the respect of those over and under him, plus a good sense of humor. He should set an example to be followed. Actions speak louder than words.

As a chain is no stronger than its weakest link, the importance of the instructor cannot be minimized. He is closest to the boys and has the responsibility of doing the direct training job. As in the case of the supervisor, his success will be reflected in his possession of satisfactory trade or academic knowledge plus the ability to understand and teach boys, a sufficient sense of humor to tolerate their mannerisms, and enough firmness to maintain discipline. He also should bear in mind that his example speaks louder than words and govern himself accordingly.

The normal length of apprenticeship at Watervliet Arsenal is four years, or 8 periods of 1,044 hours each. Increases in pay rates may be made at the successful completion of 6-month periods. At the end of three years the boys may receive journeyman's pay. Overtime is credited toward the total required length of apprenticeship.

In the formation and conduct of the program, consideration has been given to the findings of the University of Akron indicating agreement by interested parties in the following order of success of teaching methods: (1) individual assignment, (2) demonstration, (3) group discussion, (4) lecture, (5) conference. If practicable, it is well to allow each group of boys to set up their own shop under the supervision of competent mechanics, repair and set up machines, and have a part in all the headaches incident to the job. Where this was done there were plenty of headaches but the boys obtained valuable experience that developed their good qualities to a high degree and enabled them to do a highly commendable job in the shops.

IT has been found advisable to take boys on in groups of about twenty, a desirable size for a study group, at the rate of about five a week to facilitate assimilation in the shop. As soon as a boy reports for work, he is interviewed by the supervisor, told the terms of employment, what is expected of him, his opportunities, etc., in the form of a general get-acquainted talk. An individual dossier is prepared in which are placed a personnel data sheet, containing personal data, and his photograph. This is kept in the office, and all papers relating to him during his service are filed therein.

The apprentice shop is conducted on a practical shop basis, the school atmosphere being confined entirely to classes on academic subjects. One foreman is in general charge, with gang bosses in charge of lathes, milling machines, grinders, introduction, and special work. Another gang boss is in charge of shop instruction and quality control. This shop can accommodate one hundred apprentices.

The boy's first shop assignment is to a section devoted to "shop introduction," equipped with various types of machines where he operates the power hacksaw and bolt threader, performs elementary jobs on lathe and miller, spends a few days in the tool crib, is given instructions regarding kinds, use, and care of tools, and gets accustomed to the shop. He spends about four weeks here. Following assignments are to the lathe section for eight weeks, milling machines for six weeks, shapers for two weeks, and grinding section for six weeks. This consumes half a year.

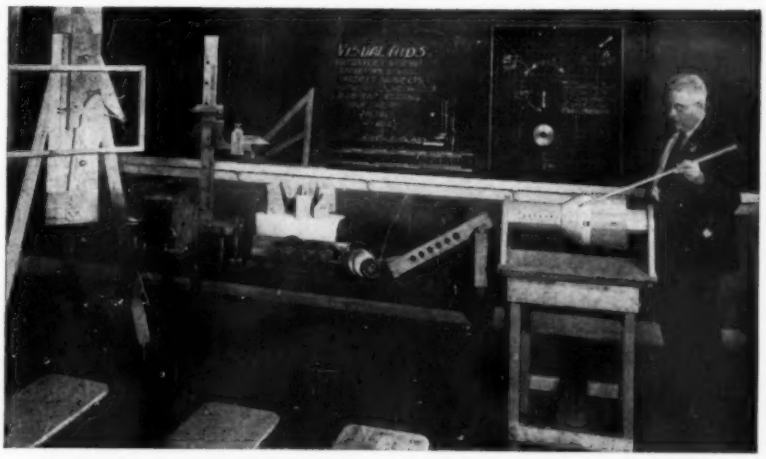
During this period and starting with the lathe section, he must start thinking by being required, before starting work on a job, to prepare a breakdown of it on a specially prepared sheet, listing his name, machine, job data, tools required, and operations which are listed as "steps" and "key points" as in the J.I.T. (job instructor training program within industry). He must also, in a space provided, make a sketch of the piece with dimensions showing the operations to be performed. This must be checked and approved by his gang boss before he proceeds with the job. Inspection is required on the first operation or piece as a further check. The time consumed by this procedure is justified by its training value in that it develops the habit of job analysis, results in more efficient work, less spoilage, and a more rapid development of understanding and proficiency.

For the second half year they are assigned to what we call "special" jobs—jobs calling for higher quality workmanship —which they carry through to completion. They also do a share of machine maintenance. By the end of their first year they are able to carry a pretty respectable job through on their own and give a good account of themselves when assigned to a production department.

In order to insure that the boys actually receive adequate training in the use of tools and machines, an "experience-

record" card lists detailed items requiring demonstrated proficiency with space for initials of instructor and date of notation. A card is assigned to each boy and follows him through the first half year. Each gang boss has a file for them. Experience has shown that machine gang bosses may forget some phases of instruction in their preoccupation with routine duties. If a boy is good at a certain operation they may be inclined to depend on him for that kind of work instead of breaking in a new boy. Periodic checks of cards and boys by the "instruction" gang boss makes sure that each boy receives the desired experience.

Many training departments keep detailed records of machine hours as a measure of proficiency. A boy may work weeks on a machine and learn only a few simple operations. The card used at Watervliet focuses attention on machine practices in which the boy should receive training and requires the gang boss's signature indicating that the boy has demonstrated proficiency in them. Clerical work is at a minimum and the information provides a more accurate picture of the boy's proficiency in the various stages of training.



VISUAL AIDS FOR APPRENTICE TRAINING AT WATERVLIET ARSENAL

The practice of weekly assembly meetings held each Thursday afternoon has been worth while from the standpoint of maintaining interest and morale. Meetings were held in an adjacent classroom, lasted for one hour, and were presided over by a president elected by the boys. Subjects discussed were of educational value connected with the trade. Fifteen minutes were allowed for matters of extracurricular interest to them, such as social, athletic, welfare topics, etc.

As a means of developing programs, four boys were named each week as a program committee. They were selected to include boys from eldest to youngest in point of service. The committees met each Monday for not longer than one hour with a gang boss who volunteered to help, and the boys, with his help, developed their program and put it across themselves. No set of instructors, no matter how imaginative, could ever have developed such variety. The gang boss tactfully directed the program toward desirable subjects. Participation of and by the boys developed a healthy interest, they learned to talk before a group, and they gained poise and self-confidence. Subjects most often discussed were safety, spoiled work, and job breakdowns. Key men from other departments often spoke by request. All instructor personnel attended meetings.

These assemblies worked well with the earlier groups of older boys, but their value decreased with the lowering of ages and decrease in numbers, and they have been discontinued. However, the assembly has definite possibilities in a dynamic program where maximum training is desired in the shortest time and under pressure.

Each month one gang boss is named by the management as safety committee representative for the department. Four apprentices are named for the month as a department safety committee to work under his direction. Each Wednesday, for one hour, these boys make a survey of the shop, each taking a geographical quarter and rotating quarters each week. Check is made for unsafe conditions and machines, poor housekeeping, etc. Report is made to the gang boss in charge and corrections made on the spot if possible. A report is made at the assembly meeting next day.

AT first glance these activities may seem to some like a great loss of time. True, a good number of machine hours are lost, but our principal responsibility is training not machine hands but machinists who are potential foremen of the future. People learn best by doing, by individual assignment. Our experience is to the effect that lost machine hours are more than compensated for by increased interest, understanding, and proficiency, by a safety record rating among the highest in the plant, and by a high standard of good housekeeping. The atmosphere of the shop is dynamic rather than static.

Also, during this first year each boy is assigned to the production engineering office for one month to assist in job planning and shop layout work. Weekly efficiency ratings on quality, quantity, and behavior for all apprentices are rendered by their direct supervisors and transcribed on individual efficiency sheets in the office. These are checked closely and irregularities immediately inquired into. All changes in assignments from section to section are effective on Mondays, lists being prepared the previous Saturday. This eliminates all confusion on this score.

Smooth working of the program is promoted through a meeting of training personnel each Friday afternoon at which policies and pertinent matters are discussed and decisions agreed upon. This gets away from one-man dictation and enlists the ideas, interest, and coöperation of the whole group. With a fast-moving, dynamic program we consider it indispensable.

Due to flexibility of operation as a training department, the apprentice division at Watervliet is able to perform many jobs outside the scope of the other shops and more promptly than through regular channels. Many tools and devices which have become standard equipment were developed in the apprentice shop, and drawings were made, the numbers of which were marked on the product, resulting in repeat orders being routed to us.

A job-control system, managed by a shop clerk, permits of accurate control of raw materials, jobs in progress, costs, and deliveries. In a sense, the apprentice division has become a service department as far as work is concerned, which has turned out very well by carrying most of our labor costs. Considering the differential between apprentice and machinist pay rates, our cost per product shows up quite favorably. Training costs to the arsenal are thereby greatly decreased.

Practically in step with shrinkage of the apprentice pro-

gram came the necessity for training large numbers of "mechanic learners" to supply the rapidly increasing needs of the expanding shops. This is a story in itself. Briefly, due to the place established in the shop organization as a service department, the training shop is continuing to function as such, but instead of being manned by apprentices only its personnel has been supplemented by women and girls who have been trained along specialized lines and are carrying on the work in a satisfactory manner. The training department and personnel are kept together, useful work is being produced, learners are trained and transferred to shops and, unless something unforeseen happens, in the future we will be in a position to accelerate apprentice training when required.

AS soon as a new group forms in the shop, classes in academic subjects start. Classes are of two hours' duration, and are taught by the supervisor of academic subjects or local state-paid instructors who operate under his supervision. Course outlines have been prepared on the basis of arsenal requirements and adequately cover the subjects from a trade standpoint. Mathematics, shop theory, and blueprint reading are the first subjects taught. After shop theory and blueprint reading are completed, a course in metals is started. A course of mechanics follows mathematics. Homework is required for all classes and is considered along with recitation and exams in final grading. T. W. I. job methods and job instructor training are planned for the future for all classes. Exams are given toward the end of each quarter, that is in March, June, September, and December. After marks are computed, they are reviewed by the officer in charge, academic instructor, and supervisor. Appropriate action is taken in cases of failures to obtain satisfactory grades.

Correspondence schools for academic subjects were considered but found undesirable because of inflexibility and cost. Boys are encouraged to take outside courses in advanced subjects, and notations of such are made in their dossiers. They are encouraged to borrow and study technical books from the arsenal's loan library. We are indebted to many industries for booklets on trade subjects, and study material has been developed around some of them.

After the first year in the apprentice department, the boys are assigned to various shop departments for the remainder of their apprenticeship. Before leaving the training department, the boys are given a pep talk and acquainted with their opportunities and responsibilities. The regular tour of duty in the various production, repair, and tool departments is six months. All boys are also assigned to the inspection and heat-treat departments for one-month periods. They are visited and checked on periodically by the supervisor. Apprentice department time clock numbers are retained until the completion of apprenticeship for record purposes.

Changes in shop assignments are controlled by a master chart which lists all assignments graphically as to department, shift, and time. Changes are effective the first Monday of each month. A tentative list is prepared two weeks in advance, giving the boys one week to make requests for changes before the final list is sent to the pay roll department. Within reason, requests are granted if they do not conflict with training requirements.

During the first year of operation of the apprentice department at Watervliet, an arsenal apprentice alumni association was formed. The interest shown by the old-timers in helping apprentices in production shops has had much to do with the development of the boys who, in these last few years of diminishing numbers of available mechanics and increasing demands for accomplishment, have had wonderful opportunities to carry on responsible tasks, and practically to a man they have demonstrated their eagerness and ability to deliver the goods.

During the period when mechanic learners were receiving preliminary training in our department at the rate of 100 to 200 a week, some of the older boys were brought back as assistant instructors. All were given instruction on the four-point job instructor training program. They were of great help to the department and received good experience in leadership. Some of these boys are already acting as occasional substitutes in the absence of production-department gang bosses and are doing a good job. Before completion of apprenticeship, boys are permitted to arrange with foremen for their permanent assignments. This puts the burden on them to make good in the places of their own arrangement. These arrangements are approved within reason and if they do not conflict with plant requirements.

The completion of apprenticeship of the 1939 and 1940 groups of boys was celebrated with appropriate graduation exercises at which they were awarded suitable diplomas and to which they were permitted to invite guests. This was a very proud moment for them and, I am sure, increased their appreciation of and pride in their accomplishment. They are practically one hundred per cent allied with the apprentice alumni association.

APPRENTICE training is slowing down again; this time because Selective Service is taking the boys. The last time the apprentice department was curtailed was during the depression as an economy step. In the light of later experience, it has been questioned whether a dollar was not lost in the effort to save a dime.

In 1940, a survey of American industry conducted by the American Society of Tool Engineers indicated a shortage of 1,500,000 skilled mechanics such as machinists, tool and gage makers, designers, etc. Competent authorities emphasize the importance of the postwar retooling job that will be required to return war plants to peacetime pursuits. Greater emphasis will be placed on new and improved methods, tools and machines for new products, and on reducing costs to meet the keen competition expected. It will have to be done fast if industry is to absorb the millions of returned service men as rapidly as will be desirable.

It is felt that sufficient men have not been trained to make up the above-mentioned shortage, much less prepare for the future. A big job lies ahead, and industry should prepare to meet it; it should be resourceful enough to work toward the desired objective with the means at hand. Some industries are doing this in the Western New York area. The Buffalo office of the War Manpower Commission is coöperating through its training technician connected with the Federal Committee on Apprenticeship.

Several concerns consider it worth while to train boys sixteen and seventeen years old, realizing that they will be drafted but feeling that their training will better fit them for war service, and with the hope that they will return to the plant after the war. Another plan in operation and viewed favorably is the application of a modified apprentice-training plan, with definite time limits and rates, to selected older and handicapped men. It should also be borne in mind that plans will have to be made for the rehabilitation and training of discharged service men.

Aircraft Gun Turrets

The Development of British Types for Aërial Ordnance

Marcus W. Bourdon

IN the realm of aircraft construction and equipment, as in other directions, Britain has been accused sometimes of displaying undue conservatism and failing, on that account, to develop practical and important innovations conceived and suggested by her aëronautical engineers. Examples of Britain's lost opportunities of leading the world in the development of the modern aircraft are provided in the history of stressed-skin construction, flaps, variable-pitch propellers, and retractable undercarriages. All these had their origin on British drawing boards, but were not carried much, if at all, beyond the experimental stage until they had been taken up, developed, and put into practical form in other countries.

But the record of Britain in this respect is not all black; there is evidence of this in the history of the power-operated gun turret for aircraft, for this is undeniably a British "invention" developed in Britain. In no other country, for a while, was it so rapidly and widely recognized as a new and highly important factor in air tactics and as a new branch of aëronautical engineering worthy of being actively fostered.

Whether Britain now retains the lead in turret design and development gained ten years or so ago is a point that cannot be discussed conclusively here and now, for it is not permissible even to hint at what, in this direction, is in prospect for the near future, either fully developed in readiness for operational use or nearing that stage on the road to maturity. But it is possible and permissible to trace the development of the aircraft gun turret in England from the outset up to a recent date and to refer in detail to the constructional features of two of the three makes of turrets now and for some while past extensively fitted to current medium and heavy bombers.

It need hardly be recalled that the provision of both defensive and offensive armament on military aircraft dates back much beyond the introduction of the first power-operated gun turret. So far as can be ascertained after a lapse of over 30 years, the military authorities of the United States were the first to contemplate and test the possibilities of a light gun installed in an airplane. This appears to have been done in 1910, a Wright biplane being used. There is, however, no trace of published results or of the conclusions reached. But it is on record that twelve months later the British military authorities expressed the opinion that "there is no likelihood of aërial scouts coming into conflict," thereby seeming to imply that the scope of military airplanes would continue to be limited to reconnaissance.

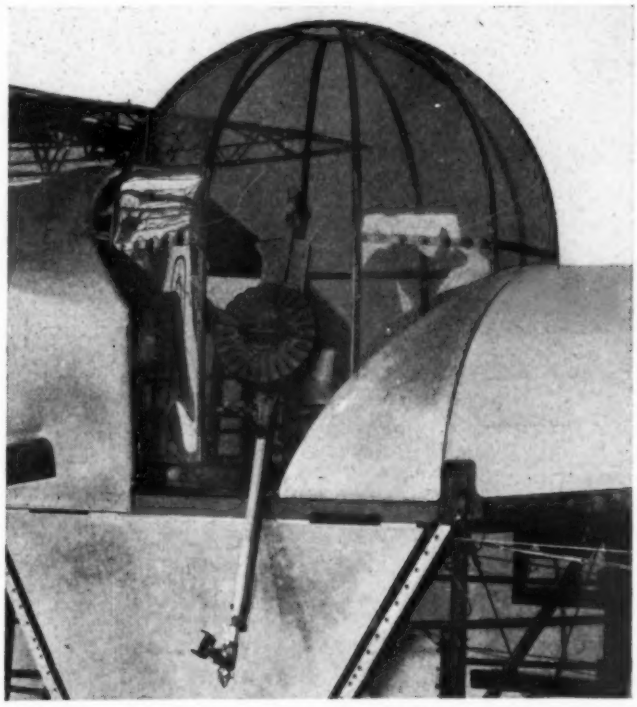


FIG. 1. THE BRISTOL "BIRDCAGE" TURRET OF 1930

This forerunner of all aircraft gun turrets was mounted on a Scarff ring and manually operated. Its guns were counterbalanced against the slipstream.

In early 1913, however, the British War Office, following some tests conducted in France and Germany, decided to experiment with armed aircraft, and the Royal Aircraft Factory fitted machine guns to some Henri Farman biplanes. In July of the same year, the British naval authorities followed suit and experimented with a Short pusher float-plane equipped with a semiautomatic Vickers 1½-pounder and, later, with a Vickers machine gun. With the latter, early in 1914, much useful experience was gained; ground targets were "attacked" from heights up to 1,000 feet, and some shooting was done using small free balloons as targets.

Meanwhile the Coventry Ordnance Company had made some tests with an armed aircraft suspended from the interior of a hangar to determine the effect of machine-gun recoil upon the stability of the machine. In 1913, too, public demonstrations of ground attack were given with an air-cooled Lewis gun weighing 26½ pounds, firing 560 rounds a minute from a magazine holding 47 cartridges. Basically, this was the same gun as was used on Allied aircraft throughout World War I and for many subsequent years, though it was gradually improved during the war until by 1918 it had a rate of fire of about 700 rounds a minute and weighed 18½ pounds with a double drum containing 97 rounds.

AT the beginning of 1914, the Vickers Aircraft Division produced their "Gun Bus" pusher biplane with a Maxim gun in the nose of the nacelle. This was the first airplane designed expressly for use as a fighter. It was an immediate success, and subsequently the opinion was widely expressed that if this machine had been put into quantity production at once it would probably have enabled the Royal Flying Corps (now the Royal Air Force) to gain ascendancy over the Germans from the outbreak of the first World War. But

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FIG. 2. FIRST POWER-OPERATED TURRET, 1934

The pneumatically operated Boulton-Paul nose turret on the Overstrand medium bomber.

the British War Office at that time favored machines built in the Royal Aircraft Factory, and, though the latter was instructed to produce a machine of similar design to the Vickers, it was not ready until the summer of 1915, by which time more advanced types of fighters had appeared on the Western Front.

Many tests with relatively heavy guns were made during the war period. These included trials with the Davis non-recoil gun, first in the U.S.A. in 1916 and then in England, and there were tests of the 37-mm. and 47-mm. Hotchkiss and of the Vickers 2-pounder. But always the same difficulty was encountered—the aircraft structures of that time were too light to withstand the recoil. True, the Davis did not suffer from this drawback, but its great length and central breech position made it unwieldy. The only "cannon" to go into operation during World War I against ground targets was a 1-pounder produced by the Coventry Ordnance Company, and in 1918 many night attacks were made with it on targets in the enemy's back areas.

The experiments and developments thus far mentioned, and many others of dates prior to the end of 1918, had relation primarily to offensive armament and none had concern with any feature devised chiefly for defense. That is to say, all were concerned with fixed forward-firing installations. Nevertheless, the provision of defensive armament in a gun turret had its origin during World War I, for on a Sopwith 2-seater biplane—the first British tractor machine to have a fixed front gun synchronized with and firing through the propeller blades—there was also fitted a Lewis gun mounted in an embryo turret. The latter was the Scarff ring mounting No. 2, the invention of Warrant Officer Scarff of the Royal Naval Air Service who also had devised an earlier form of defensive mounting, a socket-and-pillar arrangement.

The Scarff mounting No. 2 was suitable for one gun only, for when two were fitted and one of these jammed, the mounting slewed around under the recoil of the other. But before the Armistice of 1918 an improved form known as the Scarff mounting No. 6 had been developed to take two Lewis guns without the drawback mentioned. Fitted to the Bristol fighter, No. 6 mounting assisted British pilots to attain mastery in the air during the last year or so of the war and made possible the provision of effective defensive armament on the many types of bombers that appeared at about the same time, though in no case was the gunner fully enclosed.

After the war, the defenses of the bomber were gradually improved by the use of the Scarff ring mounting in a variety of positions. With this mounting, a gun position behind the tail unit was adopted initially, first on some Russian Sikorski bombers and then on the Handley Page V/1500. The Siddeley heavy bomber and the Kingston flying boat had gun rings on the engine nacelles, while on the Vickers Virginia of 1922—a biplane—special nacelles with Scarff rings and gunners were actually slung under the upper plane, outboard of the two engines on the lower plane.

The Scarff ring mounting remained a standard fitting on military airplanes of practically all countries until the progressive increase in air speeds—particularly with the coming of the monoplane—made it imperative to give gunners some protection as well as mechanical assistance in moving their weapons and holding them on the target when the gun was trained to either side of the aircraft.

TO the Bristol Aëroplane Company must be given the credit for making the first practical attempt to protect the gunner from the forces of the slipstream. A Scarff ring was enclosed within a transparent dome, familiarly and alternatively styled the "birdcage" and the "glasshouse" (Fig. 1). In this innovation of 1930 was established the basic principle of all mod-

FIG. 3. FRAZER-NASH 2-GUN REAR WELLINGTON TURRET

ern turrets. True, the enclosure was not power-driven, but it was counterbalanced to enable the guns to be trained readily and accurately against the pressures acting upon them at the speeds of aircraft in service at that time. Bristol next gave the

gunner geared hand control over both elevation and traverse of the guns; he moved with the latter and so had the advantage of always sighting through the same panel of the cupola. At about the same time, Bristol designed a hand-operated turret with remote control for a 2-seat fighter, this being the first layout in which the gunner did not occupy the turret.

Then came attempts to operate the turret by power. The first to make its public appearance was a nose turret on the Overstrand 2-engined medium bomber manufactured by Boulton-Paul, who also designed and built the turret (Fig. 2). This appeared in 1934. It was operated by compressed air and mounted a single Lewis gun. Somewhat prior to this, around 1932, Bristol had prepared designs for, but had not actually developed or made, power-operated turrets for the nose and tail of a big transport-bomber which eventually became the Bristol Bombay troop carrier.

Bristol used several systems of electric drive experimentally, but in the end hydraulics were adopted. Of the early electric drives the most successful is said to have consisted of an electric motor driving a disk from which variable-speed and reversing friction drives conveyed motion to the turret, with control by a small "joy stick." But the mechanism as a whole was not deemed sufficiently smooth in operation. Electric systems were then discarded by Bristol in favor of hydraulic operation, and this is used with pronounced success in the modern Bristol turrets installed on a number of types of military aircraft.

For Army coöperation machines, with their relatively low speed, Bristol in 1934 developed a semi-enclosed turret. This embodied a power pillar with hydraulic operation, giving sensitive control over the movements of the gun, with but slight increase in size over the earlier hand-operated mountings. During the next year, 1935, the Bristol Bombay transport-bomber, mentioned above, made its appearance with the first Bristol hydraulically operated turret, located in the nose

FIG. 4. BOULTON-PAUL 4-GUN REAR HALIFAX TURRET

of the fuselage which gave the gun a good field of fire forward.

Later, in 1936, came the first of the long series of Bristol Blenheim bombers with a gun turret amidships (Fig. 5). This type of aircraft, still on active service as a day bomber

FIG. 5. BRISTOL MID-UPPER TWIN-GUN TURRET

Developed for current Bristol Blenheim and Beaufort bombers, it is hydraulically operated.

(one version is specially equipped for use in tropical climates) is notable as having been the first example of the modern all-metal, stressed-skin, cantilever monoplane to go into production for the Royal Air Force—the first of the new era of high-performance monoplanes. The latest versions of the Blenheim still have a turret amidships only, but as a bomber it now has, additionally, a .303-inch Browning gun in the port wing and a "blister" under the nose of the fuselage with a gun firing to the rear. When equipped as a long-range fighter, the Blenheim has the same type of gun in the port wing and the top center turret, but in place of the rearward-firing gun in the blister there are four Brownings firing forward from the nose of the fuselage.

DURING the early 1930's, other aircraft manufacturing companies besides Bristol and Boulton-Paul experimented with power-operated gun turrets of their own design. Vickers, for instance, fitted its own turrets with twin Browning guns to the nose, tail, and top of the original Wellington bomber, while Armstrong used single-gun turrets of their own design in the nose and tail of the early Whitley bomber. But neither the Vickers nor the Armstrong turret was entirely satisfactory, and all later versions of the Wellington and Whitley bombers have been equipped with turrets of Frazer-Nash design made by the Parnall Aircraft Company (Fig. 3).

This make of turret (alternatively known as the Parnall and the Nash and Thompson), with the Bristol and the Boulton-Paul designs, constitutes the third of the three makes of turrets now fitted to British military aircraft. Frazer-Nash turrets, like the Bristol, have hydraulic operation. Although originally, as mentioned above, Boulton-Paul used pneumatic operation, this system was soon discarded in favor of the electrohydraulic, which, with various improvements from

time to time, is the system applied to Boulton-Paul turrets ever since.

Bristol turrets are fitted exclusively to aircraft produced by the Bristol Aëroplane Company and its associates, such as the British-built Blenheim and Beaufort, the Canadian Bolingbroke and the Australian-built Beaufort. Frazer-Nash and Boulton-Paul, on the other hand, are used as specialized productions on various makes and types of aircraft. Thus the Frazer-Nash is found on the Stirling 4-engined heavy bombers (2-gun nose and mid-upper turrets and 4-gun tail turret) and the Lancaster bomber of the same general type, but the latter has two additional guns in a ventral turret projecting below the fuselage. In all cases, the Browning .303-inch machine gun is used at present.

Boulton-Paul turrets are fitted to the Defiant night fighter and, among other British and American aircraft operated by the Royal Air Force, the Halifax (Fig. 4) and Liberator heavy bombers, the Lockheed Ventura and the Lockheed Hudson—for many of the last-named are still in service. Some Fleet Air Arm machines also have the Boulton-Paul turret.

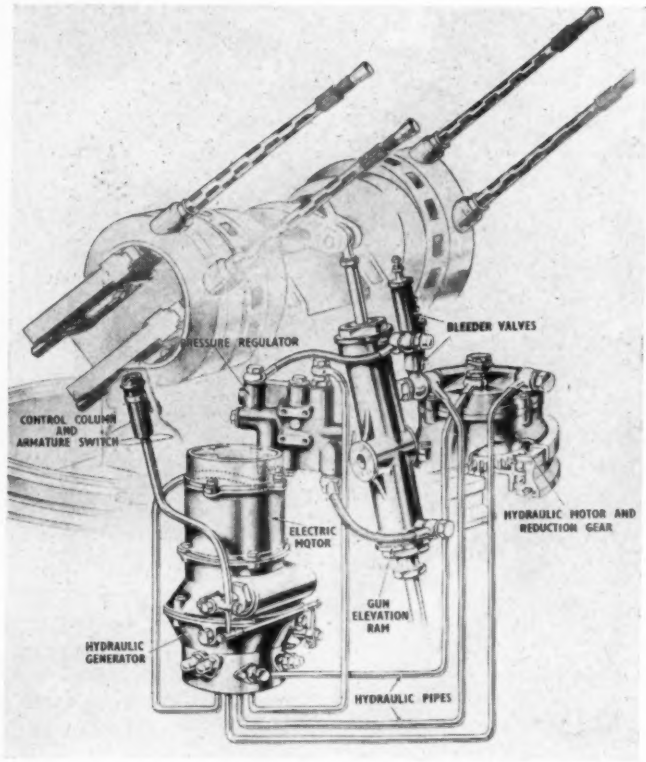


FIG. 6. BOULTON-PAUL POWER-CONTROL SYSTEM

Turning to the constructional features of British power-operated turrets now in use—so far as these may be revealed—it may be said, first, that the success of the Bristol series is very largely dependent upon the Bristol hydraulic pump, which, besides its adoption for turret operation, is used extensively for many other aircraft services on various makes and types of machines and forms part of the back cover auxiliary equipment for numerous makes of aircraft engines, British and American, water-cooled and air-cooled. It has been described by one aëronautical engineer as "the salvation of aircraft designers." It is a 3-stage pump giving pressures up to 1,500 pounds, or more if required, with a smooth flow of six imperial gallons a minute at normal engine speed.

From the outset, a feature of Bristol turrets has been the moving seat for the gunner synchronized with gun movement. Another is the secondary motion of the column on which each gun is mounted. By means of this the gun does not always point radially from the center of the ring but may be trained to fire directly past the aircraft tail and rudder. Mention may be made of a detail associated with this secondary motion of the gun column; *i.e.*, the provision of a flexible chute through which spent cartridges are jettisoned. The construction of this chute is such as to allow for a wide angle of movement without risk of "collapse."

The makers of Bristol turrets claim them to be simpler and lighter than other types, easier to manufacture—since they do not involve fine limits—of about half the weight of most other types with the same armament, and considerably smaller than any other with the same effectiveness, number of guns, supply of ammunition, and field of fire.

By means of a restriction gear and fire cutout, it is possible for the gunner to rotate his turret at full speed without fear of damage and to avoid shooting off or fouling any part of the fuselage or tail unit. The gun mounting also incorporates a simple "harmonization gear" which enables the four guns (where four are fitted) to be lined up on the target quickly and independently. A quick-release device makes it possible to remove and replace the guns easily without handling anything except the guns, which are automatically locked in position when pressed home. It is possible also for the gunner to "service" any gun in the air without removing it from its mounting.

Details are available and are given hereafter relating to the Boulton-Paul series, but correspondingly full particulars cannot be given at present regarding the Frazer-Nash and Bristol turrets, though the following information has been released concerning the Frazer-Nash hydraulic motor, a unit contributing largely to the success of this make of turret.

FOR the limited motion required for the elevation and depression of the guns of the Frazer-Nash turrets, simple hydraulic rams are used; but, as it is essential for traversing that there should be unlimited rotation of the turret, a rotary hydraulic motor is provided. The unusual design of this unit is of interest. It is operated by pressure derived from the hydraulic pump available on the engine for other services and is of the multiple-vane type. It differs notably, however, from the usual vane type of pump in which, it may be recalled, the stator has a plain eccentric bore with spring-loaded vanes sliding within recesses formed in the rotor body. This conventional arrangement may serve where the rotor speed is consistently high, where pressures are low, and where intercell leakage is of no great importance.

But in an oil motor for the operation of a gun turret pressures are high, speed at times is very low, intercell leakage —particularly at low speeds—must be negligible, and it is preferable that the vanes shall not slide within the rotor during the pressure stroke of each vane. To satisfy the latter condition, the tip of each vane must move on an arc concentric with the rotor spindle during the working stroke. Spring loading must be avoided, for if a vane should stick, or tend to do so, there is no centrifugal force to come to the rescue at low speeds.

In the Frazer-Nash hydraulic motor, therefore, the internal profile of the stator consists of two arcs joined by what, developed on a straight-line basis, is a serpentine curve. To control the sliding of the vanes each in-sliding vane is used to actuate

an out-sliding one, diametrically opposite, through the agency of light tappet rods passing through the rotor. There are six vanes paired in this way, with their tappet rods staggered to enable all to pass through the rotor from side to side without fouling one another.

After tedious experiment to find a shape of blade tip affording the best possible seal under line-contact conditions and to effect hydraulic balance of the vanes, the design was so satisfactorily stabilized for production that practically no modifications have been necessary to cope with the increasingly heavy duties imposed on the unit from time to time. Turret torque figures at the outset of the present war were already twice those current when the Frazer-Nash hydraulic motor was designed. Present-day figures cannot be quoted, and all that can be said regarding the performance of this unit is that it operates accurately and smoothly over a speed range from zero to 1,000 revolutions a minute and that it is capable of dealing with pressures up to 1,500 pounds per square inch.

Boulton-Paul discarded compressed air for turret operation chiefly because it imposed such short limits to the periods during which the turret could be in continuous use, and every spell of action had to be followed by an interval to enable air bottles to be recharged by a motor-driven compressor. An electrohydraulic system was therefore adopted, and the present-day equipment is notable for its compactness, simplicity of control, and quick response.

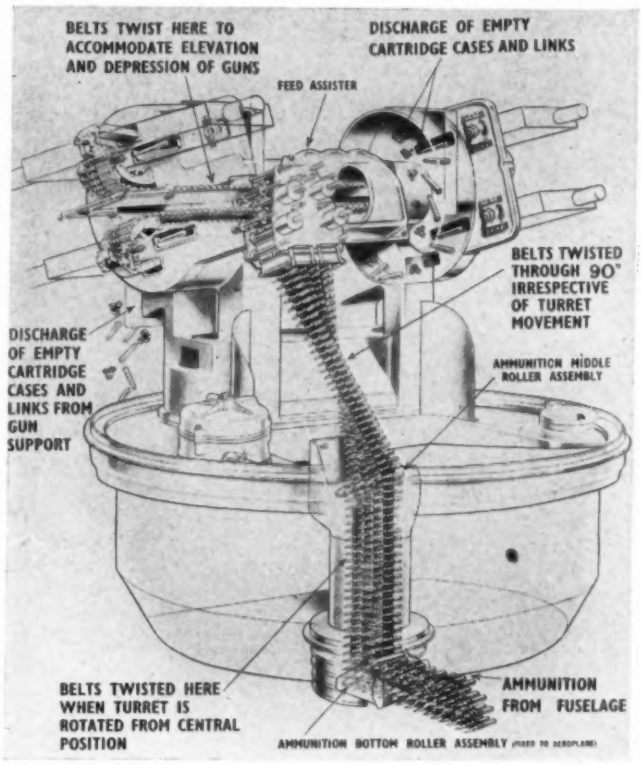

BELTS TWIST HERE TO ACCOMMODATE ELEVATION AND DEPRESSION OF GUNS
DISCHARGE OF EMPTY CARTRIDGE CASES AND LINKS
FEED ASSISTER
BELTS TWISTED THROUGH 90° IRRESPECTIVE OF TURRET MOVEMENT
DISCHARGE OF EMPTY CARTRIDGE CASES AND LINKS FROM GUN SUPPORT
AMMUNITION MIDDLE ROLLER ASSEMBLY
BELTS TWISTED HERE WHEN TURRET IS ROTATED FROM CENTRAL POSITION
AMMUNITION FROM FUSELAGE
AMMUNITION BOTTOM ROLLER ASSEMBLY

FIG. 7. BOULTON-PAUL REAR TURRET AMMUNITION SUPPLY

An important feature of the Boulton-Paul system is that the hydraulic section is confined to the rotating portion of the turret, which avoids the difficulty of transmitting high-pressure fluid from the power source through rotating joints. Among other possibilities of failure avoided are pipe dilatation, differential thermal expansion between pipes and fluid, and leakages and fractures caused by vibration. Benefit in the latter respect results from short pipe lengths and the ability to bend them to conform with the adjacent structure, to which they can be cleated conveniently.

Complete power units are built into the turret; leads for electric power and other services are taken to a slip-ring unit on the axis of rotation. Installation on the aircraft consists, therefore, merely of dropping the complete turret into position, lining up, bolting down, and coupling up electric services and, in some cases, an external oxygen supply. All ground tests and adjustments can be made before installation. In the event of a turret being damaged it can be quickly removed and a duplicate installed.

The control incorporates a grip lever or "dead-man's-handle," which, when depressed, energizes an electric motor but cuts out the latter when pressure is released (Fig. 6). The Boulton-Paul hydraulic generator has relief valves set to blow off at a pressure which, at full output from the generator, limits its power to that obtainable from the electric motor. There is, therefore, no danger of one or the other being overloaded. Movement of the control handle imparts stroke to the pistons of the hydraulic generator, the power output being proportional to (a) the stroke imparted, which governs the speed of turret movement, and (b) the pressure built up in the hydraulic system (up to the maximum blow-off pressure) determined by the external resistance to turret movement.

THE generator, running up to 1,230 r.p.m., is driven by a constant-speed 24-volt electric motor running at 4,000 r.p.m. and coupled through planetary gearing to the generator to form a single unit. The generator comprises two separate pumps, one connected in a closed circuit to a hydraulic motor for turret rotation, and the other, also in a closed circuit, to a ram for elevation and depression of the guns. A pressure regulator provides a hydraulic lock on the guns in elevation and depression and thus prevents "creep."

The control slides for the two pumps are so connected to the control handle that movement of the latter to the left or right turns the turret in the corresponding direction, while movement of the handle backward or forward elevates or depresses the guns. Both pumps are controlled independently, and azimuth and vertical traverse can take place separately or simultaneously. With the control in the central or neutral position, the control slide ring is concentric with the cylinder block and no delivery takes place, the pistons then having no stroke. When the column is moved from neutral, the slide ring is displaced in relation to the cylinder block, imparting stroke to the pistons which move inward during one half of the cylinder block revolution and outward during the other half, producing suction while they are in communication with one port in the distributor and delivery when they communicate with the other port.

A supply of oil is carried in a sump of the generator for making up internal leakages, when needed, through suction valves in the circuit. Overload protection is given by blow-off valves in each line, set at pressures of approximately 1,000 pounds to the square inch. Small electric heaters of approximately fifty watts' loading are provided in the hydraulic circuit and are automatically cut out when the turret is in operation. Others are fitted to the hydraulic generator and motor, guarding against faulty operation at low temperatures.

The Boulton-Paul hydraulic motor is of the 7-cylinder elliptical-cam type of ⅞-inch bore and 0.45-inch stroke. In this case, also, the cylinder block is the driven member, rotating on a stationary distributor spindle. Power strokes occur in

opposite 90-degree sectors, and the motor is reversed by reversing the supply of fluid from the generator by movement of the control handle. Materials used are similar to those of the generator, with delivery and exhaust ports formed in the distributor spindle, provision being made for adjustment of the port timing by partial rotation of the spindle. The approximate maximum speed of the motor is 200 r.p.m. Connection with the main driving gear of the turret is made through planetary gearing. Gun and seat rams, where the latter are fitted, follow normal practice.

Each gun is fired electrically by a separate solenoid, with a single firing button for all guns in the top of the control column and a safety isolating switch in the circuit.

TO provide automatic protection for surrounding parts of the aircraft, such as the tailplane, rudder, and fin, an electrical fire interrupter is embodied in the firing circuit (Fig. 8). As the guns are some distance apart, there is independent interruption for the right-hand and left-hand guns, so that maximum firepower can be obtained. The interrupter consists of a brass drum with two spring-loaded brushes held in contact with it. The brushes are located one above the other on a frame and are free to slide up and down the drum surface to accord with gun elevation and depression. Firing circuits for the left-hand and right-hand pairs of guns (in a 4-gun turret) are fed by the upper and lower brushes respectively, while a fixed brush in permanent contact with the drum forms the other connection for the circuit.

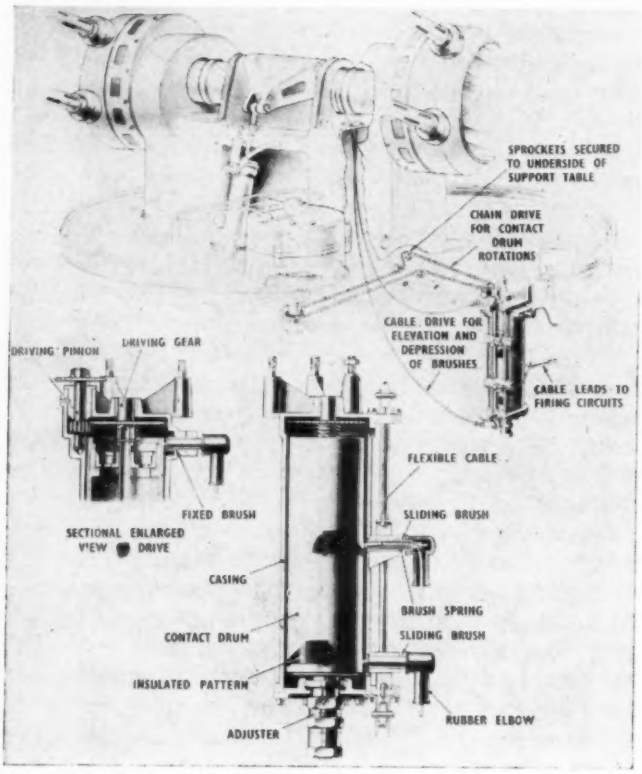


FIG. 8. BOULTON-PAUL FIRE-INTERRUPTER SYSTEM

On the upper half of the drum, shadow patterns corresponding with the obstructed areas of the left-hand pair of guns are cut out and filled flush with molded insulating material, so that in passing over these areas the upper brush is isolated and firing of the left-hand pair of guns is interrupted. In the same way the lower half of the drum surface carries insulated areas corresponding to the obstructed areas in the field of fire from the right-hand guns. These shadow patterns are usually designed from a turret mounted in an aircraft, allowances being made for aircraft deflections and gun characteristics. No matter how complicated the shape of the aircraft, it can be adequately protected in this way, with a minimum loss of field of fire.

Ammunition systems generally follow normal practice but the tail-turret feed deserves mention. To minimize weight in the tail, the ammunition is carried in the fuselage and led to the turret in steel runways or tracks (Fig. 7). Although this makes possible a greatly increased ammunition capacity, it has a disadvantage in that the guns cannot be fed under their own power. To overcome this, a power-driven assister, in which the ammunition belt runs over toothed sprockets carried on a hinged arm, is driven through gearing from the turret electric motor. Normally the belt sprockets are free, but when tension of the ammunition belt exceeds a predetermined figure, the hinged arm is moved by belt pull and applies a band brake to a planetary gear unit in the drive between motor and sprocket, thus providing a power drive which tends to overfeed the guns. When sufficient overfeeding has occurred to reduce the belt tension the hinged arm returns to its normal position and disengages the power drive. Although the foregoing indicates a definite sequence of operations, in practice the feed mechanism is always working, the tension and band-brake application adjusting themselves to gun requirements. Safety devices in the form of quickly replaceable shear couplings are fitted to prevent damage to belt or feed assister.

The Boulton-Paul turret mounting ring is distinctive. It consists of two fully machined magnesium-alloy castings assembled to constitute a double-row cageless ball bearing. The lower row of balls supports the weight of the turret and the upper row takes the radial loads. The main driving gear ring, with internal teeth, is attached to the upper surface of the magnesium castings. The lower ball race conforms to normal practice, the balls running in a groove in the fixed ring. The track for the balls in the upper race is different; there is a small interference fit between the inner and outer races and the balls. The inner race is turned to a smooth finish, but the outer one has fine feed tool marks left, and, when assembled and run in, the balls roll a track into the ridges formed by the finishing tool. This produces an assembly free from objectional diametrical clearances.

Some surprise may be felt at the running of steel balls on a magnesium-alloy track, but tests have shown that, provided a suitable value for unit ball loading is selected, excellent results are obtained; there is no "pickup" of the ball race, which actually improves with use owing to work-hardening effect. Similarly, gun trunnion bearings through which the ammunition passes to the guns are of the full-ring needle-roller type running direct on the magnesium alloy.

Boulton-Paul produces a wide range of turrets for nose, tail, mid-upper and under positions; they are all equipped with auxiliary services, such as oxygen, intercommunication, and an outlet for the gunner's clothing-heater plug.

EDITOR'S NOTE.—For information on and illustrations of the types of turrets and armament used on airplanes of the U. S. Army Air Forces, the reader is referred to "Aërial Firepower" published in the September-October 1943 issue of ARMY ORDNANCE (Vol. XXV, No. 140, p. 341) which pictures the use of the machine gun in American aircraft.

Invasion Fleet

WORLD WAR II is an amphibious conflict. Our successful landings in North Africa, Sicily, and Italy, and the invasion of many Japanese-held islands of the South Pacific have been effected by ship-to-shore and shore-to-shore transport of thousands of men and tons of equipment and supplies—all of which will be as but a dress rehearsal compared with the coming all-out attack on Germany's "European Fortress."

These amphibious operations, however, which we now regard as commonplace, could not have been achieved without enormous numbers of specially designed landing craft, some of the larger of which were not even thought of three years ago. Various types of small personnel landing craft, however, were planned by the Navy's Bureau of Construction and Repair as early as 1935, and, after a long period of testing, the *LCV (Landing Craft, Vehicle)* and the *LCP (Landing Craft, Personnel)* were developed from the well-known Higgins boats. The *LCVP (Landing Craft, Vehicle-Personnel)* combines the functions of both and transports light vehicles and troops from ship to shore. Large numbers of the *LCR (Landing Craft, Rubber)* were also ordered at this time.

Plans for a light-tank lighter were completed by the Navy in 1937, but the increasingly important rôle of the medium tank in armored warfare led to the development of the *LCM (Landing Craft, Mechanized)* which can carry a medium tank or a bulldozer, heavy truck, or large artillery piece.

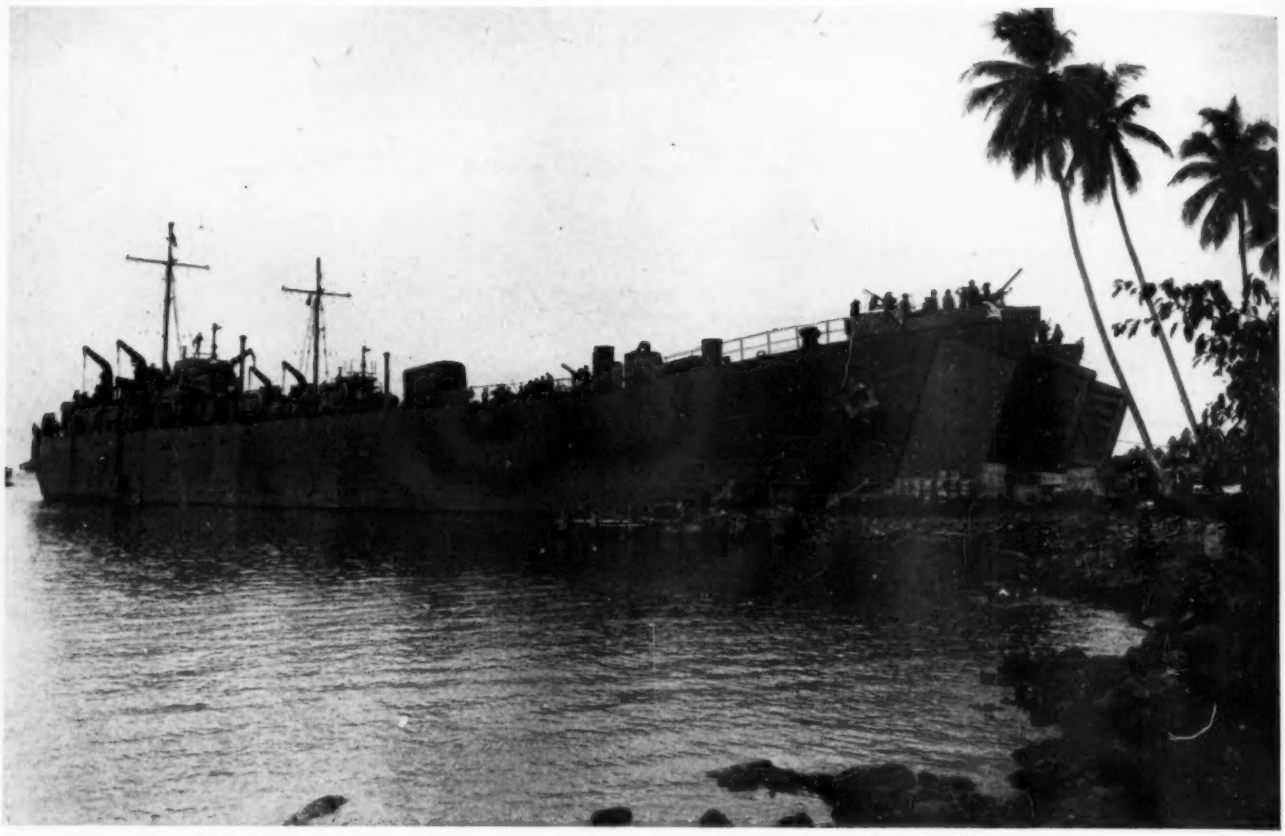
Largest of the landing craft is the *LST (Landing Ship, Tank)*, known also as the "Green Dragon" and "Ugly Duckling." These ships are 327 feet long, displace 5,500 tons, and can transport hundreds of tons of tanks, vehicles, guns, and other equipment across vast ocean distances and land their cargoes directly on the beach. They also transport troops and evacuate the wounded.

The *LCT (Landing Craft, Tank)* is an intermediate landing vessel, smaller than the LST but larger than the LCM. Both the LST's and the LCT's were put under construction in May 1942.

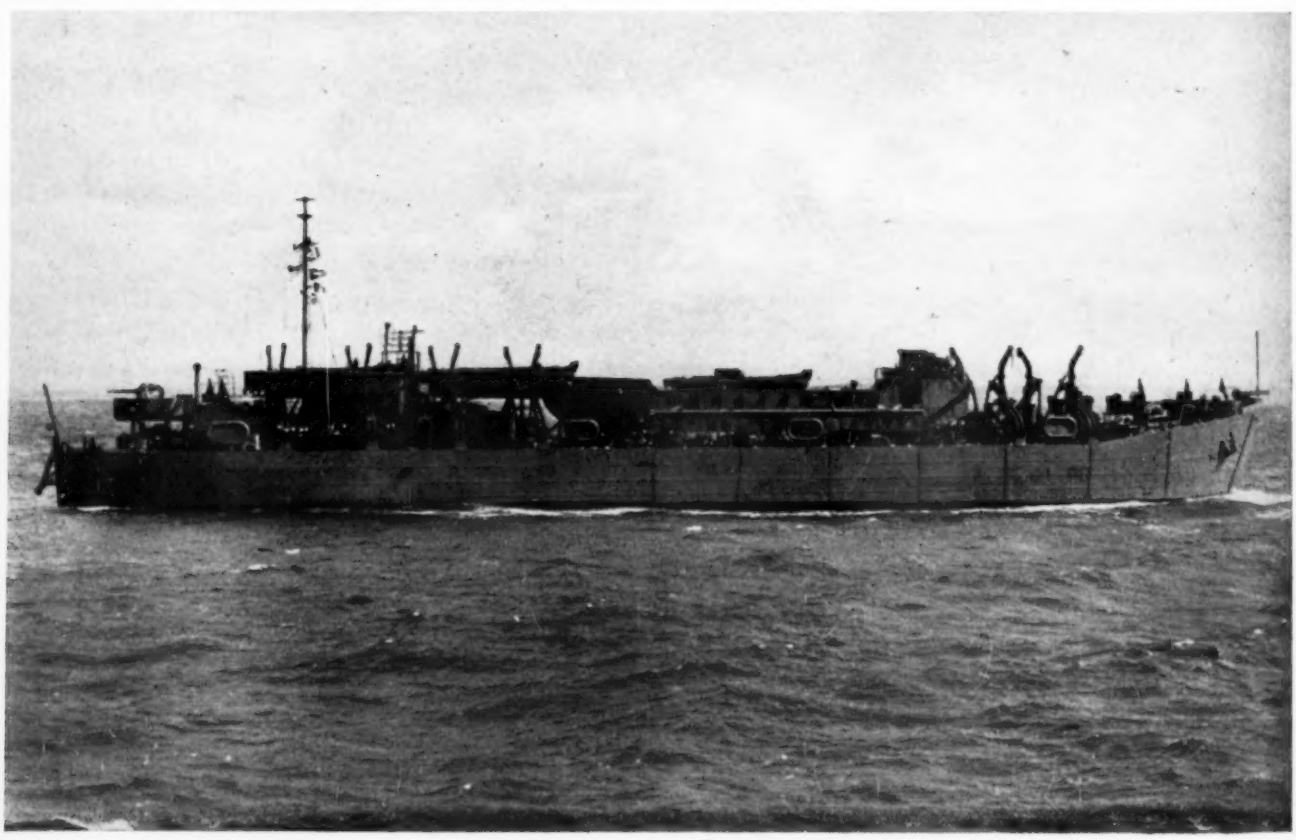
In October 1942, after requests from the British for a larger vessel to serve both as an infantry landing craft and troop transport, the first *LCI (Landing Craft, Infantry)* was completed. This vessel can carry heavily armed men across wide bodies of water and land them directly on the beach. Other types of Navy landing craft are the *LCC (Landing Craft, Control)* used to regulate and direct landing efforts; the *LCS (Landing Craft, Support)* armed with rocket weapons and machine guns which pin down and destroy the enemy so that the other vessels may reach the beach safely; the *LVT (Landing Vehicle, Tracked)*, an amphibious tractor which can cross swamps and reefs—armored types are used like tanks against enemy strong points; and the *LSD (Landing Ship, Dock)*, a 450-foot vessel used to facilitate docking operations when the beachhead is secured.

The accompanying illustrations of America's modern invasion armada are from official U. S. Navy photographs.

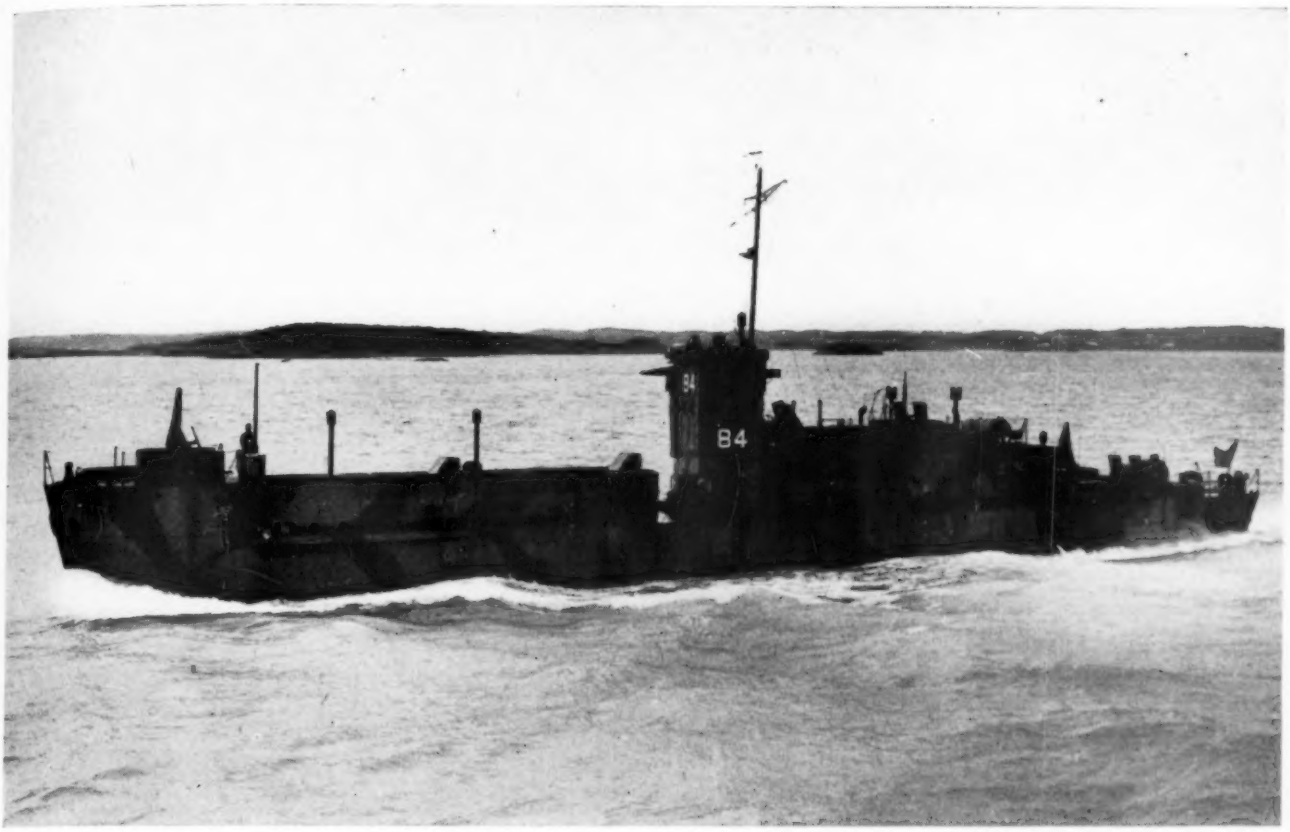
LST—Landing Ship, Tank



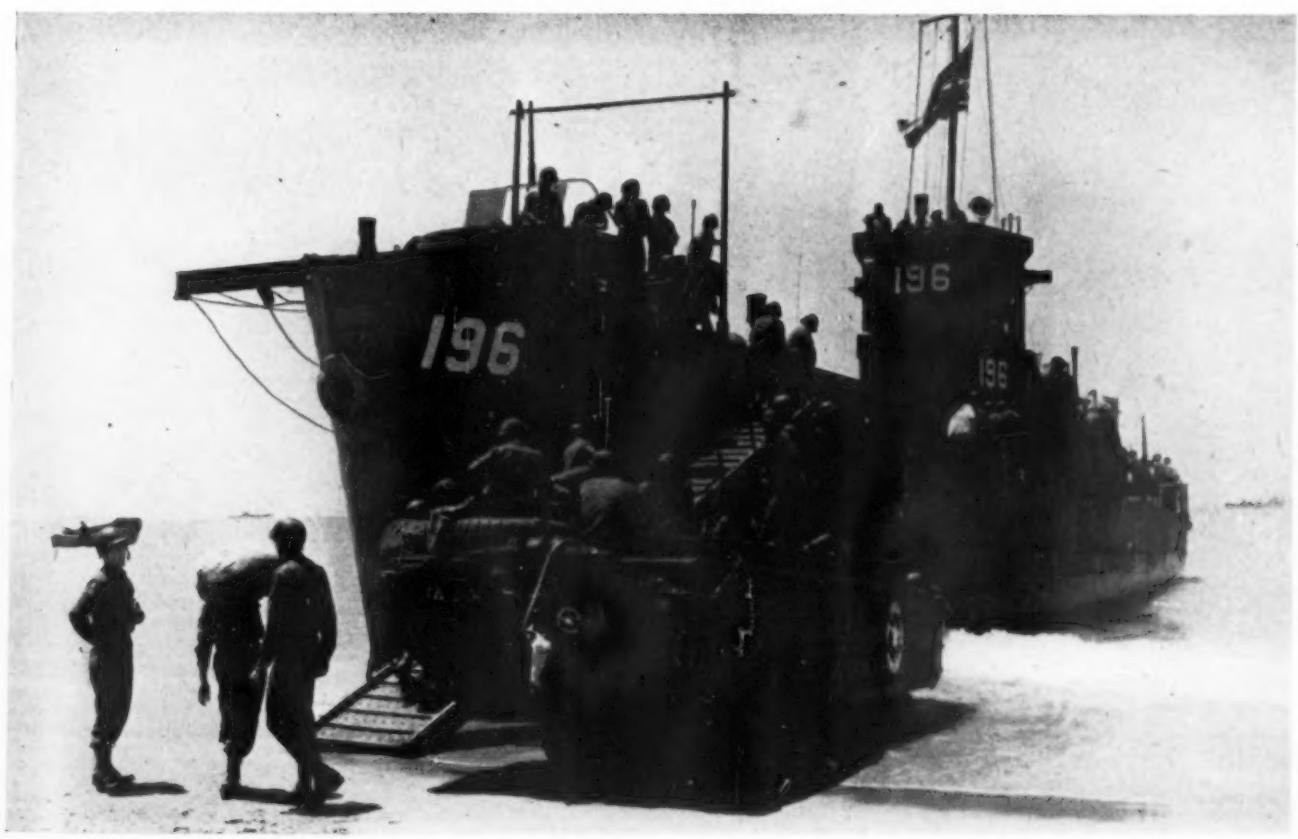
The LST's, largest of the landing vessels, carry vehicles and other equipment on their decks and in their holds and disgorge their cargoes directly on the beach through the bow doors, as shown above. The LST below is shown en route to an invasion area carrying an LCT—in which are nestled smaller craft—on its deck and LCVP's on davits along the sides.



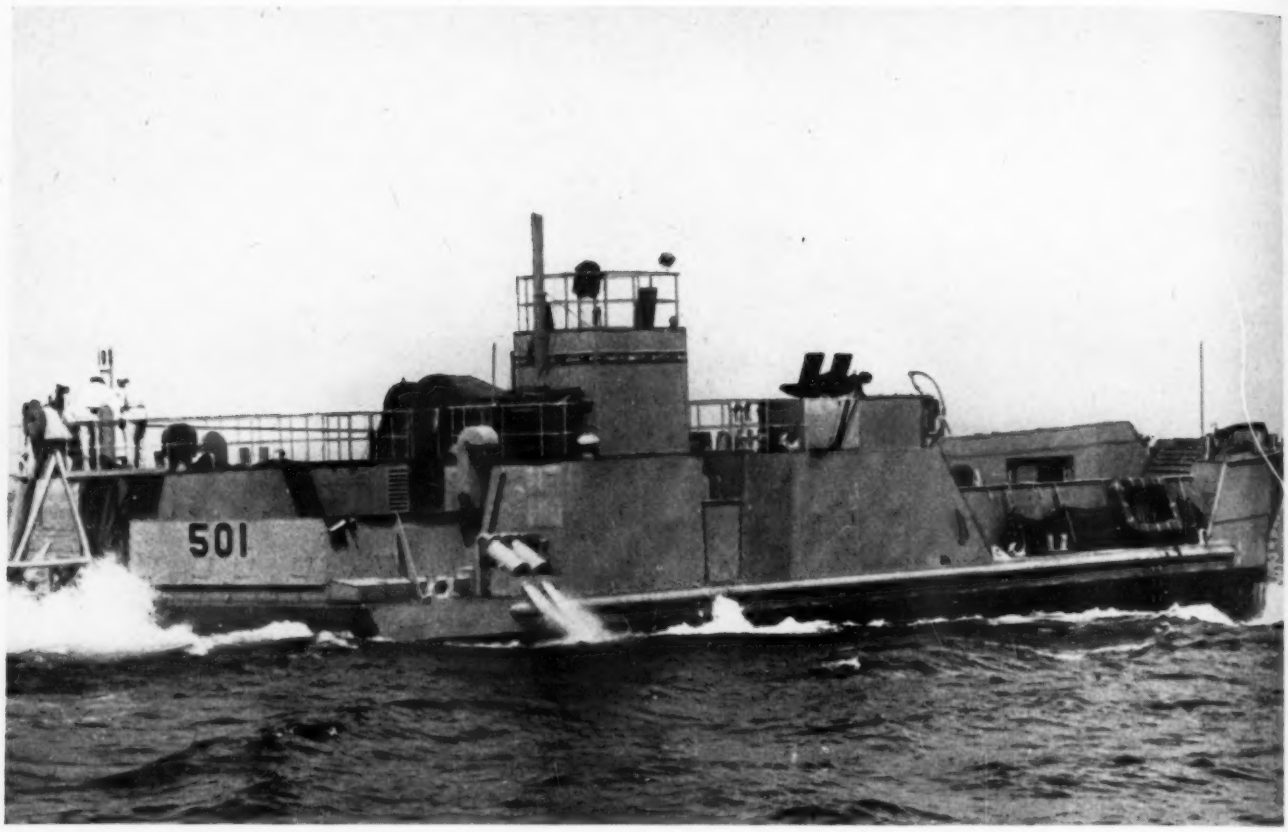
LCI—Landing Craft, Infantry



The LCI carries about 200 infantrymen and is 155 feet long. It is the only landing craft besides the LST which can transport large numbers of troops over long distances. The LCI above is shown under way, while the one below is shown beached with its ramp almost touching dry sand. Alongside is an Army 2½-ton amphibious truck known as the "Duck."

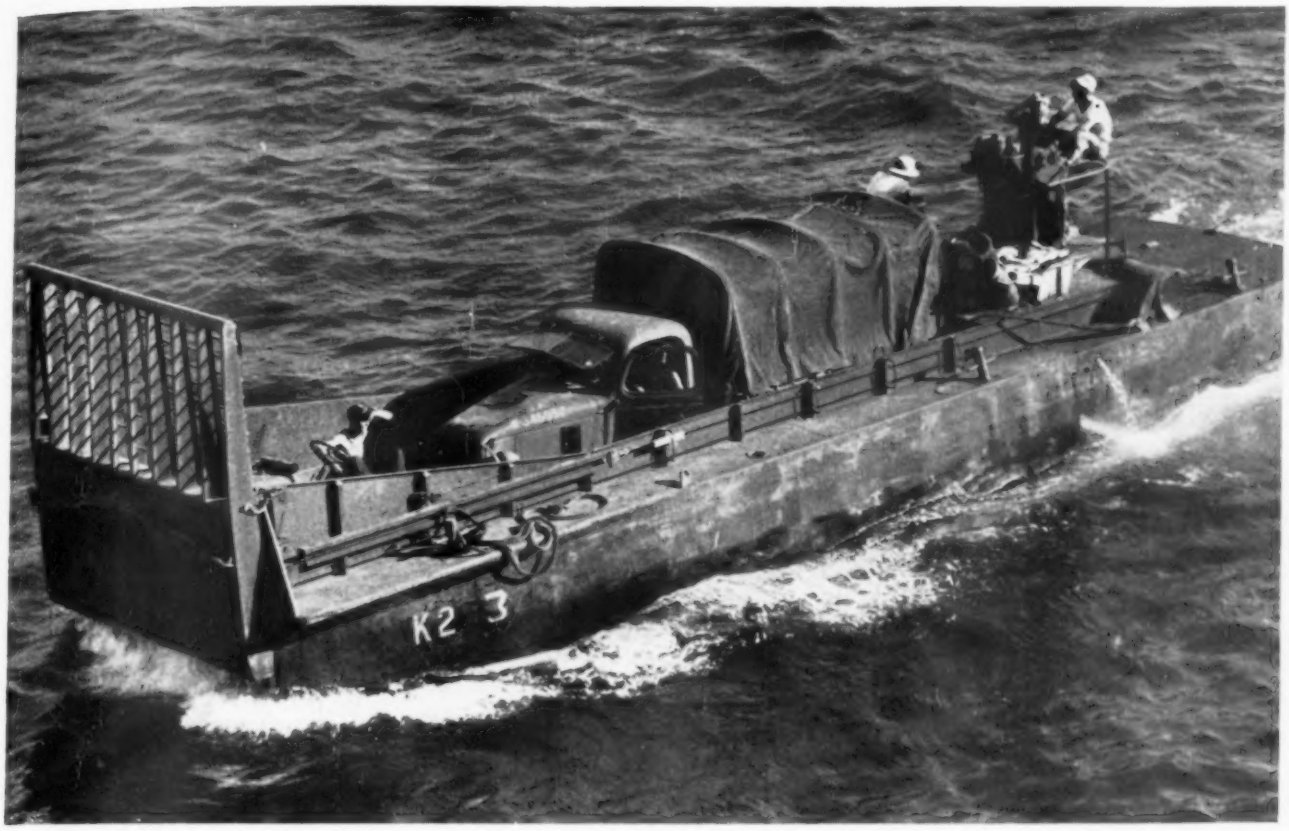


LCT—Landing Craft, Tank



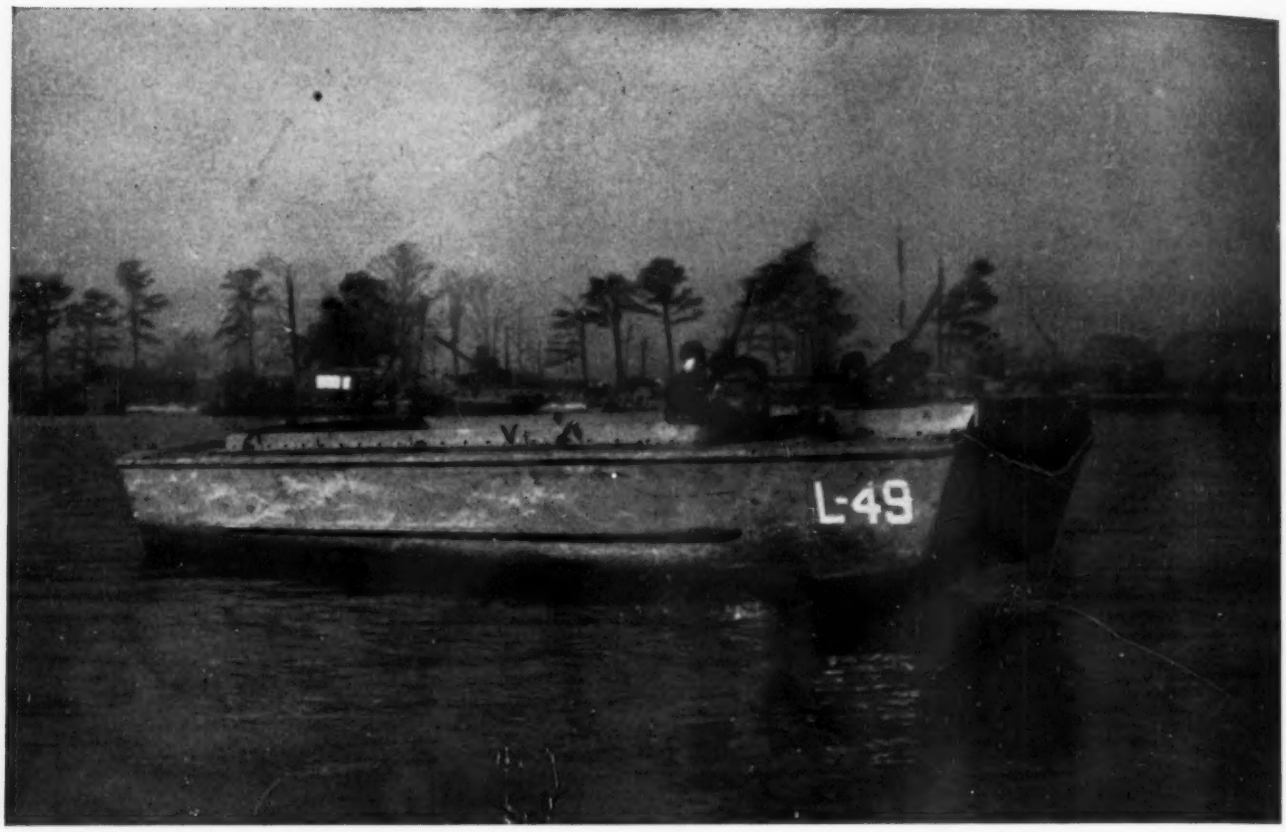
The Navy's latest tank-landing craft—the LCT, Mark VI—is shown above. Besides tanks and trucks, the LCT's can transport huge quantities of other cargo such as shown stowed aboard earlier model LCT's below. These craft are about 100 feet long and are carried to the theater of operations aboard LST's or cargo ships. They can also transport many troops.

Landing Crafts—Vehicle and Mechanized



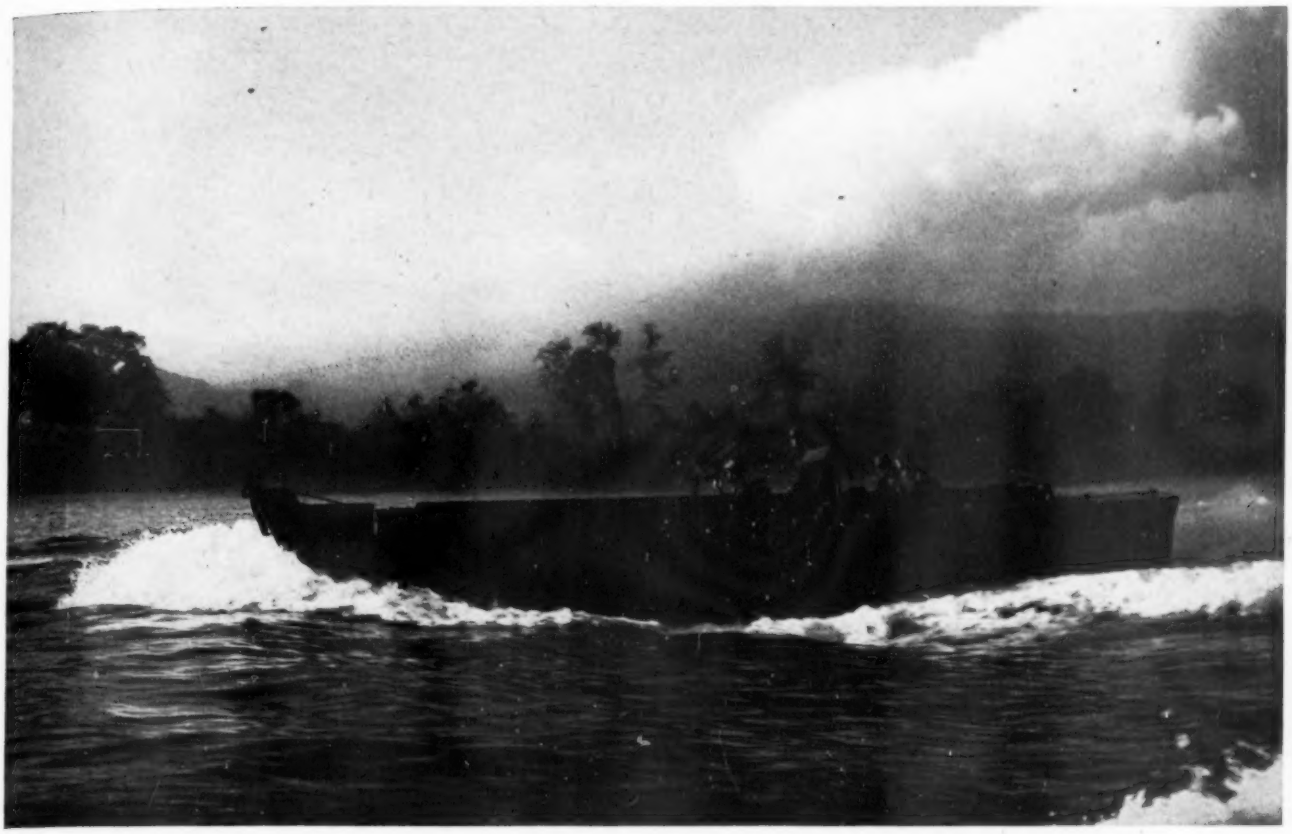
The LCV, above, is used for landing troops and light vehicles. It is about 36 feet long and makes medium speed loaded. Note the long ramp which enables vehicles to reach firm ground without bogging down. Below, a truck is shown leaving an LCM with a 40-mm. antiaircraft gun in tow. This craft can land medium tanks, bulldozers, or other heavy vehicles.

LCP—Landing Craft, Personnel

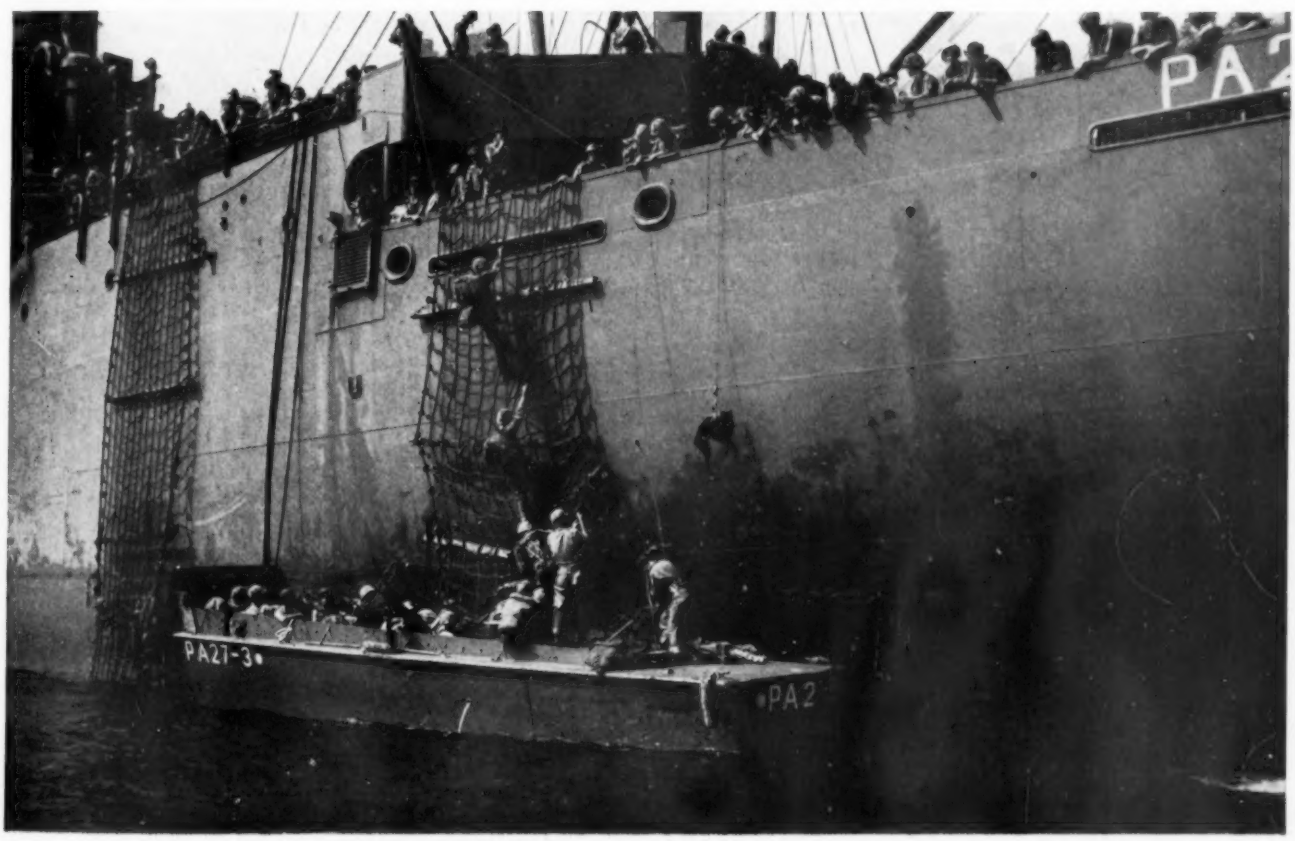


The LCP, above, is a speedy personnel transport. It is armed with 2 Lewis antiaircraft guns for local protection and has a ramp in the bow over which the troops pour ashore. The LCP, below, is a lighter version of the personnel carrier. It also is equipped with 2 machine guns but has no bow ramp. Like all small landing craft, it is carried aboard transports or LST's.

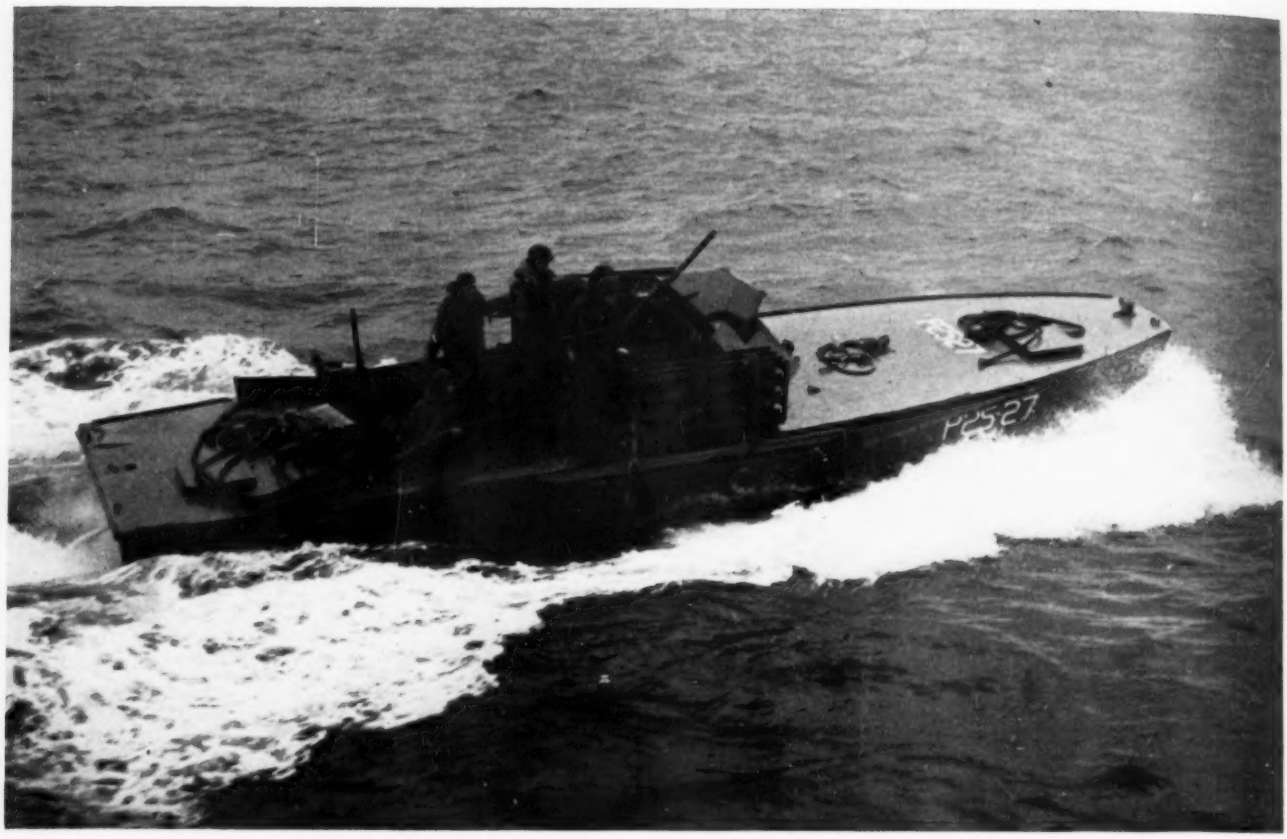
LCVP—Landing Craft, Vehicle-Personnel



The LCVP is a ship-to-shore craft of simple design but many uses. It carries troops and vehicles such as jeeps, trucks, and light tanks. It is armed with 2 light machine guns, as shown above. In the illustration below, troops clamber down a landing net to the waiting LCVP as a "dog of war," used in detecting concealed Japs, is lowered aboard in a sling.



Special Landing Craft



The LCS (Landing Craft, Support), above, is a speedy armored boat which defends other landing craft from air attack and lays down a machine-gun and rocket-shell barrage ahead of invading troops. The LVT (Landing Vehicle, Tracked), below, is the Navy's new amphibious tractor known as the "Water Buffalo." It is ideal for freeing craft caught on reefs.

Twenty-Fifth Annual Meeting

The Army Ordnance Association Marks Its Silver Anniversary

THE Silver Anniversary Meeting of the Army Ordnance Association was held on January 19, 1944, at the Waldorf-Astoria Hotel in New York City. The day-long activities included a meeting of the Association's national officers and directors, a series of round-table conferences on the four principal phases of Ordnance endeavor, a display of American and enemy matériel, and a dinner and general session in the Grand Ball Room at which the Association's Gold Medals for Distinguished Ordnance Service were awarded to three outstanding leaders of the Ordnance cause—Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, U.S. Army; Rear Adm. W. H. P. Blandy, former Chief, Bureau of Ordnance, U. S. Navy; and Tom M. Girdler, chairman of the Association's Committee on Endowment.

PRESENTATION OF THE CROZIER MEDAL

Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance (left), receives the medal from Brig. Gen. Benedict Crowell, president of the Army Ordnance Association (right).

The national officers and directors of the Association met in the Italian Garden Room of the Waldorf at 11 A.M. for their annual meeting. A full report of their deliberations will be published at a later date. Suffice it to say complete cognizance was taken of the Association's coming rôle as the principal leader of postwar industrial preparedness, and steps were taken to make sure that the society is ready to accomplish effective work in that task. Plans have been formulated to increase the membership of the Association greatly and to expand its publications and services.

Registration for the members and guests attending the meeting began at 2 P.M., and the round-table conferences started at 2:30 with the Ordnance production and field-service sessions. Maj. Gen. Thomas J. Hayes, chief of the Ordnance Industrial Division, presided at the Ordnance Production Round Table in the Astor Gallery. Panel speakers were: K. T. Keller, president, Chrysler Corporation; E. B. Yancey, general manager, explosives department, E. I. du Pont de Nemours & Company; Roy T. Hurley, special assistant to the president, Bendix Aviation Corporation; Col. I. A. Duffy, chief of the Legal Branch, Office of the Chief of Ordnance.

Brig. Gen. Julian S. Hatcher, chief of the Ordnance Field Service Division, was the presiding officer at the Ordnance Field Service Round Table held in the Jade Room. Speakers at this conference were: Fred C. Bahr, vice-president, Chrysler Corporation; Irving Babcock, president, Yellow Coach & Truck Company; Maj. Gen. Charles L. Scott, Commanding General, Armored Command, Fort Knox, Ky.; Herbert T. Holbrook, assistant to the chief of the packaging section, Production Service Branch, Ordnance Industrial Division.

The Ordnance Engineering and Training Round Tables began at 4:30 P.M. The session on Ordnance engineering was held in the Jade Room with Maj. Gen. G. M. Barnes, chief of the Ordnance Technical Division, presiding. The panel speakers at this session were: Dr. C. F. Kettering, general manager, Research Laboratories Division, General Motors Corporation, and chairman, National Inventors Council; W. J. Meinel, president, Heintz Manufacturing Company; Capt. W. M. Moses, U.S.N., director, Research and Development Division, Bureau of Ordnance, U. S. Navy; Dr. F. B. Jewett, president, National Academy of Sciences, and member, National Defense Research Committee; Maj. Gen. Albert W. Waldron, U. S. Army, veteran of Guadalcanal; Dr. Gordon S. Brown, director, Servomechanisms Laboratory, Massachusetts Institute of Technology; Clifford Roberts, director of research, United Shoe Machinery Corporation; Lieut. Col. V. H. Krulak, U.S.M.C., Headquarters, U. S. Marine Corps.

Brig. Gen. H. R. Kutz, chief of the Ordnance Military Training Division, presided at the Ordnance training session in the Astor Gallery. The speakers at this round table were: J. E. Johnson, director of training service, General Motors Corporation; Dr. H. P. Hammond, dean, School of Engineering, Pennsylvania State College; Col. W. R. Slaughter, commandant, The Ordnance School; Dr. R. E. Doherty, president, Carnegie Institute of Technology.

A complete report of all the addresses given at the Round Table Conferences will be published in a series of brochures and mailed to all members of the Association in the near future.

DURING the period between the close of the round tables and the dinner meeting, more than 1,500 members and guests of the Association viewed the exhibit of ordnance matériel which was on display in the Silver Corridor and the East Foyer. This exhibit was arranged through the courtesy of Brig. Gen. C. T. Harris, Jr., Commanding General of Aberdeen Proving Ground, Md. It included captured German and

Japanese weapons as well as some of the latest pieces of American ordnance—notably the bazooka antitank rocket launcher.

The Annual Dinner began at 7 P.M. when the guests of honor marched from the Basildon Room to take their places at the daises set on the huge stage of the Grand Ball Room. The assemblage was called to order by Brig. Gen. Benedict Crowell, president of the Association, and the National Anthem was sung by all as spotlights illuminated rippling American flags at the front of the darkened room.

Immediately following the dinner, General Crowell called the general session to order with these words:

"This marks the beginning of the twenty-fifth year of constructive service for our country by this Association. As president during that period, I welcome you most heartily to this historic meeting. Never before have we assembled with a global war being waged at such terrific tempo and never with victory so sure to be ours if we continue to exert our greatest national effort.

"Tonight we are meeting in this place to do honor to several of our coworkers who richly deserve our acclaim. Meeting here in the city of New York, it is entirely fitting that our toastmaster should be the president of our great New York Post. He is one of our outstanding leaders in Ordnance, whose contribution to the winning of this war is of the highest order from the standpoint of engineering as well as production of vital ordnance equipment. I present to you Mr. Reginald E. Gillmor, president of the New York Post."

Tom M. Girdler

Chairman of the Association's Endowment Committee—Rice Medalist.

IN acknowledging this introduction, Mr. Gillmor said: "This gathering is unique in the history of American industry and of our armed forces. In this room are assembled the representatives of the industrial power of America and the Ordnance power of our country. Together, these two great forces have welded into unity a fighting machine the like of which has never been seen in the history of the world.

"We are gathered here tonight to pay special tribute to three men who have performed exceptionally meritorious services toward the winning of this war. We are also met to hear an address by one of industry's greatest leaders who is giving to our war production the impetus and drive so essential to its success. Before presenting these gentlemen, may I sound what I should like to call the keynote of this meeting, which marks the beginning of the twenty-fifth year of the Army Ordnance Association. That keynote is striking in its simplicity. It is this: 'Industrial preparedness is our strongest guaranty of peace.'

"A quarter of a century ago, our society was founded for that purpose and for that purpose only. We have never departed from that purpose. No organization has striven more constantly nor against greater odds for industrial preparedness. Every day of this war proves again and again that this purpose must never be forgotten. Therefore, I give you as our theme for the future that our armament research, development, production, and supply must always be in the joint trusteeship of American industry and our fighting services. The trustee is and always must be the Army Ordnance Association. The responsibilities which faced it in the twenty-five years that are gone are small compared with the responsibilities during the twenty-five years that lie ahead—but we shall not fail!

"Our Association now numbers over nineteen thousand of the leading engineers of American industry, many of them on the home front, many in uniform on the fighting fronts. That numerical strength must be trebled and quadrupled if the responsibility that lies ahead is to be met.

"Every industrial organization, every technical and engineering skill, every component of American industry must ever be aware of the needs of modern warfare and must be ready and willing to meet its responsibilities without the delays and confusions which might otherwise be incurred. American industry, in coöperation with the fighting services, must not only see to it that this war is won promptly, efficiently, and effectively, but that the same close partnership must continue through all the years ahead so that the lessons now being learned at such great cost may never again be forgotten.

"The Army Ordnance Association will see to it, with your help and that of all our members, that this responsibility is met fully and completely. Appropriate of that sentiment, I want to read to you a telegram received just a few minutes ago from a great American. It is from Bernard Baruch, and he says: 'I regret more than I can say that owing to continuous detail work here I am unable to get to the Ordnance Association meeting. If you have an opportunity, please express my best wishes for their continued success, for on their success depends so much of the country's welfare.'

"TONIGHT, we are to confer honors upon three distinguished fellow citizens who richly deserve them. The candidates have been chosen by our Committee on Awards, whose chairman, Colonel Payne, will present the candidates and read the citations. The medals will be conferred by General Crowell, our president. I now call upon Col. Frederick H. Payne, vice-president of the Army Ordnance Association, chairman of our Committee on Awards, and formerly Assistant Secretary of War in the Cabinet of President Hoover."

COLONEL PAYNE then introduced the Army Ordnance Medalists with the following remarks:

"On behalf of the Committee on Awards and with the approval of the directors of the Army Ordnance Association, I am pleased to announce the following awards for distinguished Ordnance service for the year 1943. The Crozier Gold Medal, founded by the Association in honor of Maj. Gen. William Crozier, the renowned Chief of Ordnance from 1901 to 1918, is awarded to Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance of the United States Army, with the following citation:

"'The Army Ordnance Association acclaims the Chief of Ordnance of the Army of the United States for his leadership and ability in the conduct of the vast responsibilities of the Ordnance Department in the present World War. The Ordnance Department under his direction has continued the mammoth program begun in 1940. Throughout the world-wide operations of the Army of the United States and the forces of the allied nations, there has been no case where ample ordnance in quality and quantity has not been available. The Association honors General Campbell with its medal bearing the name of another distinguished Chief of Ordnance, Maj. Gen. William Crozier, for his part in the construction of the special facilities for the production of ordnance equipment and for the organization of special committees throughout American industry for the integration of techniques and facilities to the end that the entire industrial strength of the Nation could be coördinated for armament production.'"

REAR ADM. W. H. P. BLANDY

Former Chief, Bureau of Ordnance, U. S. Navy—Scott Medalist.

General Crowell then conferred the Crozier Medal upon General Campbell who responded in the following words:

"FRANKLY I am not sure that I am going to be able to make a speech, because I am quite overwhelmed; but I will try.

"No one individual can be worthy of the Crozier Medal—it means too much. Therefore, I accept this medal on behalf of all my fellow Ordnance officers, some 25,000 strong, and of the civilians of the Ordnance Department, some 200,000 strong, and also on behalf of some 400,000 Ordnance enlisted men. I accept also on behalf of our team mate—American industry.

"General Crozier was the father of modern ordnance. He reduced ordnance engineering to an exact science. His was the engineering and administrative leadership that aided the Ordnance Department of the Army in becoming the great institution it is. I have had conferred upon me tonight an additional honor—one which I shall always hold very dear. Mrs. Crozier, who is sitting in the first box in the first tier to my left, has consented to be here tonight. Mrs. Crozier! (The audience arose and applauded.) As Chief of Ordnance of the Army and on behalf of the Ordnance Department and the Industry-Ordnance team, may I salute you, Mrs. Crozier! (Applause.)

"In the Ordnance Department all have done a great job. I know that I have done little myself, but I have had lots of devoted help. No one will ever know the friends who have rallied to my side with honesty and patriotism and loyalty to their country—they are legion. No one can ever convince me of any flaws or faults in the Industry-Ordnance team because results speak for themselves!

"Our quality of ordnance under the great work of Major General Barnes is echoing back in a steady tidal wave from the theaters of war. He has carried on the Crozier tradition of Ordnance engineering. The quantity of ordnance going to the front is an avalanche. The production leadership of the Industry-Ordnance team has been furnished by that very great soldier and administrator, General Hayes. The supply and the maintenance of our weapons all over the world have been directed by a real man and a real leader, General Hatcher. The young men who have been trained in ordnance operation and maintenance are serving throughout the world. Their training in ordnance and in leadership is the work of a fine soldier, General Kutz, chief of Ordnance military training.

"And so I could go on and call the roll of all the officers who are doing this Ordnance job. But it is not being done by any one of us—it is 25,000 of us, and it is 200,000 Ordnance civilians and the thousands in industry at our side. We in the Ordnance Department early recognized that this was a job for industry. We did not find industry wanting, and again I say to industry that we of Ordnance and you of industry stand for integrity and fair dealing at all times and for more and better ordnance.

"I want to say just a word about this great Army Ordnance Association which, for twenty-five years, has carried the torch of armament preparedness in a wilderness of doubt and indifference. There is no organization within my knowledge which has paid a bigger dividend to the country than has this Association, and I am very ambitious for it. I want to see a large membership of highly intelligent and patriotic people in whatever walk of life they may be. That will be good for this country because it will help guarantee our strength.

"You of the Association have troublous years ahead after the peace. It is such people as you who will carry forward industrial preparedness and make this country survive. The Army Ordnance Association must stand for one thing, and

that is to maintain for Ordnance the industrial supremacy which in this war has made us what we are today—a mighty Nation with victory in sight!

"And so, let us, Army Ordnance Association, bend our efforts to securing the necessary funds and support to lead the way, with Navy Ordnance alongside us under the great leadership of Admiral Hussey, our new Chief of Naval Ordnance. Let us lead the way so that Ordnance secures the necessary national support. With industry and science and engineering in our great country, let us lead the way to constant military strength through Ordnance engineering and American industrial supremacy!"

COLONEL PAYNE then continued: "The Scott Gold Medal, founded by the Association in honor of Frank A. Scott, the first chairman of the War Industries Board, 1918, and chairman of the General Munitions Board in the first World War, student of military history and exponent of industrial-mobilization planning, is awarded to Rear Adm. W. H. P. Blandy, Chief, Bureau of Ordnance, U. S. Navy, with the following citation:

" 'The Army Ordnance Association acclaims the Chief of the Bureau of Ordnance, United States Navy, for his leadership in the design, production, and supply of naval ordnance to the first line of our national defense. Of wide naval experience and sound industrial judgment, Admiral Blandy's tenure as Chief of the Bureau of Ordnance has been especially marked by the complete coöperation between the personnel and establishments under his direction and those of the Ordnance Department of the Army. This coöperation, which has attained signal benefits in World War II, is a splendid criterion of the coöperative endeavors which should always exist between these most important armament organizations. The Association honors Admiral Blandy with its medal bearing the name of Col. Frank A. Scott, also an outstanding exponent of coöperative endeavor on the part of American industry with the defense forces of the Nation.'

"Admiral Blandy, during the past month, has relinquished his duties as Chief of the Bureau of Ordnance of the Navy and is now on duty with the fleet in battle areas. In his absence, the medal will be received by his successor as Chief of Navy Ordnance, Rear Adm. George F. Hussey, Jr. I will ask General Crowell to confer the medal upon Admiral Blandy and to present it, in Admiral Blandy's absence, to Admiral Hussey."

General Crowell then presented the Scott Medal to Admiral Hussey who responded as follows:

"BEFORE taking up my rôle as proxy, I should like to express to you the pride which we in Navy Ordnance feel at the honor you have conferred on Admiral Blandy. It is a source of great gratification that you, who are closely associated with our brothers in Ordnance, have thus recognized our Chief . . .

"Admiral Blandy had no detailed knowledge of the wording of the citation, but in discussing the matter with me he made it clear that he regarded this honor as evidence of the splendid coöperation which existed between the Bureau of Ordnance of the Navy Department and the Ordnance Department of the Army. He has ascribed no small part of that to the leadership of General Campbell to whom he looked up as a master of ordnance.

"Parenthetically, I should like to add that I am enjoying that same coöperation and looking forward to a continuation of the coöperative dealings with General Campbell which began when I was commander and he a lieutenant colonel at Frankford Arsenal some years ago!

"Today has been one of particular pleasure for me because I have found among you a great many of the friends that I made during my various contacts with the Bureau of Ordnance. To find so many of you as members of Army Ordnance brings home to me more clearly than ever how closely Army Ordnance and Navy Ordnance lie together, how their interests and their needs are closely intertwined. . . .

"There is no need to tell you that the fight is still on; that we have many thousands of miles to go before we occupy Berlin and Tokyo. All of you are thoroughly aware of your responsibilities and our responsibilities—speaking as 'our' for General Campbell and myself. While we are carrying out those responsibilities, it behooves all of us to make sure that there is set up a sound basis for continuing research and development of ordnance in the years to come after the war, which we must regard not as postwar years but as prewar years. Very close to Admiral Blandy's heart was the formation of some sound organization which would insure that research in ordnance, ordinarily neglected in peacetime security, should be carried on after it.

"General Crowell, on behalf of Admiral Blandy, I accept this medal as representing the Army Ordnance Association's appreciation of the close relationship between the Bureau of Ordnance of the Navy and Army Ordnance and, with that, the splendid coöperation which existed between both Ordnance organizations and American industry."

COLONEL PAYNE then continued: "The Rice Gold Medal, founded by the Association in memory of Col. John H. Rice, outstanding Ordnance administrator and Chief Ordnance Officer of the American Expeditionary Force in Europe in 1918, is awarded to Mr. Tom M. Girdler, chairman of the Army Ordnance Association's Endowment Committee, with the following citation:

" 'The Army Ordnance Association acclaims the chairman of its Committee on Endowment, who rendered outstanding service to the national defense of the United States through his leadership in this cause. Of wide industrial experience, Mr. Girdler brought to the Army Ordnance Association a vast contact with American industry which enabled its endowment to attain its projected goal. This endowment for all time assures that industrial preparedness in the United States will continue to be a basic principle of industrial-mobilization planning. It will thus contribute in large measure to the safety and security of the Nation. The Association honors Mr. Girdler with its medal bearing the name of Col. John H. Rice under whose tutelage Mr. Girdler began his long association with American industry more than forty years ago. Thus are linked the names of two outstanding exponents of armament preparedness in our country.'

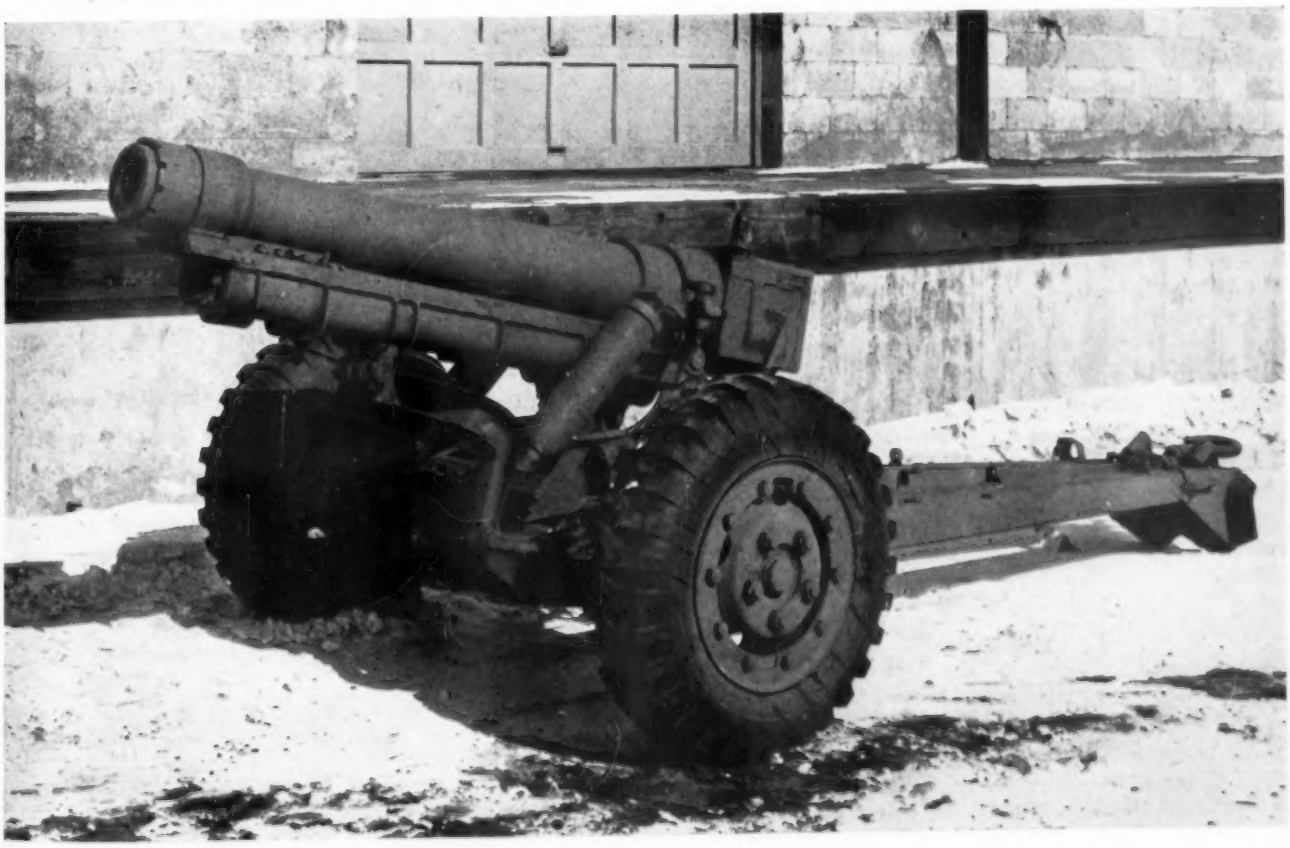
"Mr. Girdler, at the last moment, was detained on the West Coast by urgent engagements relating to the conduct of the war. The medal will be presented to him at a later date.

Mr. Gillmor then introduced the principal speaker of the evening, Charles E. Wilson, Executive Vice-Chairman of the War Production Board. Mr. Wilson's address is published in full on page 285 of this issue.

In bringing the meeting to a close, Mr. Gillmor said: "All of us are pledged to industrial preparedness for war as one of our strongest guaranties of peace. That pledge is now being fulfilled to the limit of our energies. It is a pledge which will bring us victory and sustain the peace that follows."

New Ordnance Matériel

Shown above is the Army's new gun motor carriage, M8, consisting of a 75-mm. howitzer mounted in an open turret on the M5 light tank chassis. It also carries a caliber .50 antiaircraft machine gun. The new weapon is used mainly to bombard hostile personnel with high explosive. Below is the light 105-mm. howitzer on its mobile carriage (Signal Corps photo).



Automotive Tool Supply

The SODTICIOAP Program for Ordnance Maintenance Equipment

C. B. Smith

THE launching of SODTICIOAP was not an attempt to break all existing records of name coining or to establish a new Government agency. In fact, it was not an agency or an organization; it was an "action" program, scientifically designed to perform a definite mission. This mission, in so far as the "nom de plume" reference is concerned, has been accomplished, and permanent Army Ordnance organizations are following through to assure the continued flow of sufficient quantities of maintenance tools and equipment to our using organizations at the right place at the right time.

SODTICIOAP—pronounced "Soda-cap"—means Special Ordnance Depot Tool Identification, Classification, Inventory, and Obsolescence Analysis Program. As a program, it was carefully planned, timed, and executed by the Ordnance Department and the country's tool-and-equipment industry. Immediate results obtained were outstanding and very definite in nature. Critically needed tools and equipment were promptly placed at the disposal of Army organizations, and the program made possible a knowledge of Ordnance assets of tools and equipment as to location, condition, and quantity. With this information, Ordnance was placed in a position to balance requirements against assets and through businesslike methods to dictate the necessary action to take care of shortages, establish priorities on critical items, and, a matter of great importance, plan to dispose of excess stocks in an orderly manner.

From a statistical standpoint, 52,923 tool and equipment items, some duplicated between depots, were analyzed by the teams at depots, training centers, and ports of embarkation. These items, multiplied by components, many running into the thousands, some into hundreds of thousands, give a better picture as to the enormous amount of work done by this Ordnance-Industry combination.

Of the 52,923 items analyzed, the teams in the field were able definitely to establish proper identification, effect consolidation of stocks, and apply the correct nomenclature and storage-and-issue numbering on 80 per cent. A list of the remaining twenty per cent was forwarded to the Office of the Chief of Ordnance, Detroit (formerly known as the Tank-Automotive Center), where, as of January 5, 1944, another twelve per cent had been properly handled.

To accomplish the objectives of SODTICIOAP was not an easy assignment. The question was often raised: "Why get excited about such relatively commonplace items as open-end wrenches, socket wrenches, pliers, hammers, screw drivers, air compressors, battery chargers, grease guns, etc.?" Most people had accepted these commonplace automotive-repair items as something easy to get and always available. However, war conditions which created huge demands for these items also made such tools and equipment difficult to supply to the right place at the right time. The importance of all types of maintenance tools and equipment has, since Pearl Harbor, been accentuated by prevalent news reports from theaters of war, indicating that more lives have been saved through emergency repair than through the use of armament, steel helmets, and similar protective equipment. Furthermore, it has long been recognized that the tool is the link between man and machine and assures the successful operation of our war matériel.

With the importance of maintenance tools and equipment definitely established, even before critical distribution problems came into being, it was recognized by the Ordnance Department that a nation-wide audit, inspection, and classification of tool and equipment stocks in Ordnance depots, along with improved methods of storage and issue, were not only necessary but essential to the successful prosecution of the war.

THE growth of Ordnance from a peacetime organization of 300 officers and an annual business of $15,000,000 to 22,000 officers and a yearly business of many billions of dollars is now a familiar story. Expansion of any business, even that of one of our well-established corporations, creates many problems. To double the volume of a business involving all phases—from engineering and development, through procurement, production, storage and issue, then distribution to the various channels and finally to the consumer customer—is quite an undertaking. So for Ordnance to expand a skeleton peacetime operation several thousandfold resulted in overtaxing all existing facilities including management, man power, machines, storage space, transportation, and every factor of distribution. Add to this the fact that it was not until after Pearl Harbor that many executives from industry were any more than mildly interested in going into active Government service to contribute their efforts toward what was actually an industrial and not a military operation.

The small Ordnance organization, prior to and at the beginning of the war, did a marvelous job in procuring and expediting all types of automotive matériel. But because of anxiety to secure enough goods to perform the task, all types and kinds of tools and equipment were procured and shipped under almost as many different kinds of marking, numbering, and packing systems. So there is little wonder that huge quantities of tools and equipment, handled by relatively inexperienced personnel in Ordnance depots, became temporarily misplaced or unavailable for issue to the armed forces. The important thing in the early days of the war was to get all types of war matériel, get them quickly, and think about balancing and refining the procurement program when the sword was not pointed at our Nation's throat.

During the Battle of the Atlantic, the African and other campaigns, huge quantities of tools and equipment were expended and lost, resulting in a critical situation. To complete the cycle of fabrication of tools and equipment in quantities from raw materials to the finished product takes time; digging out large quantities of tool and equipment stocks on hand in Government depots and warehouses throughout the country, then reclassifying and substituting, permitted quicker methods of producing these items. This

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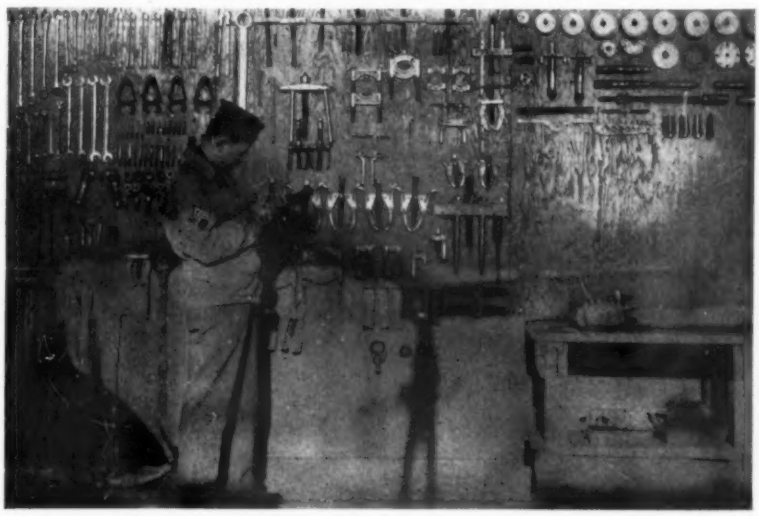
is the course the Ordnance Department sought to follow in order to take care of the critical demands placed upon it.

Realizing that large quantities of tools and equipment could be made available immediately by searching out, properly identifying, classifying, renaming, and making substitution of items in Ordnance depots, a team of four men from Ordnance was assigned in June 1943 to "guinea-pig" the proposed SODTICIOAP program. It was soon determined from the information developed by this team that there was not sufficient experienced tool and equipment personnel available in Ordnance to complete a program of this nature in the required time. So it was decided to handle this important program with dispatch by teaming up with the maintenance tool and equipment industry.

It had long been the policy of Maj. Gen. Levin H. Campbell, Jr., Chief of Ordnance, to make use of Ordnance-Industry teams to handle difficult industrial problems, but this was the first large-scale project of a field-service nature to receive consideration for an operational hookup with industry. Representatives of industry taking the leading part in the conferences with Ordnance to complete plans for SODTICIOAP included Rodgers Palmer, vice-president of Snap-On Tool Corporation and president of the Service Tools Instiute; J. W. McDonough, president of Sherman-Klove Company; W. R. Hosford, sales manager, Duro Metal Products Company; H. B. Curtis, president, Bridgeport Hardware Manufacturing Company; and George P. Byrne, secretary of the Service Tools Institute.



SPECIAL TOOLS FOR HALF-TRACK MAINTENANCE INDICATE THE COMPLEXITY OF DESIGN AND THE PROBLEM OF IDENTIFICATION

THE work of the Ordnance tool-and-equipment team which had been contacting Ordnance depots, working on procedures for such a nation-wide program, was discussed with representatives of industry. It was pointed out that Ordnance definitely recognized the opportunity of making available additional quantities of tools and equipment through proper identification, reduction of a range of items, consolidation of stock, substitutions, etc., but to do a thorough job in the time required would necessitate the services of thirty-five to forty key tool-and-equipment men from an already-hard-pressed tool industry. The industry not only professed an interest in the program but immediately underwrote the project by guaranteeing sufficient qualified personnel from their own organizations.

Unanimous Ordnance approval of SODTICIOAP was given at the Ordnance depot commanders' conference held in Chicago on August 26, 1943, and the contract was signed in New York on September 7, 1943, with the Service Tools Institute representing the tool-and-equipment industry, thus assuring the necessary services of the industry.

In order to launch this program, it was essential that the personnel going into Ordnance depots and other Army installations be familiar with such Ordnance tool-and-equipment terminology and procedure as standard-nomenclature lists—the Army's tool-and-equipment catalogue—and the storage and issue system of ordnance, etc. Therefore, a training period at St. Louis from September 20 to 23, 1943, was recommended as an essential part of the program.

On the first day of the school, all industry representatives took the oath of allegiance and were advised that they were to deal with what amounted to restricted and confidential information. The school schedule, of necessity, called for strict organization of those in attendance. Competition was keen among the forty-three men from industry since it was announced early that only thirty-five men would qualify for the work. Some were appalled by the size and scope of the Ordnance program. An example was given of an Ordnance depot warehouse, a 1-floor building covering 775,000 square feet of floor space—large enough to play 17 football games simultaneously and have enough room left over for spectators.

Another example was cited where it was rumored that forty carloads of tools were on the tracks of a certain depot to be unloaded. One of the high-ranking officers, when questioned about this huge quantity of tools replied: "Forty carloads of tools? Hell, why that's just an express shipment!"

The depot "locator system" was explained to be a means of determining the physical location of storage. Whether the item was placed at one or more positions in the warehouses did not matter; the locator file would provide the details of warehouse number, section, tier, and bin location as well as reserve locations.

Depot "temporarily coded items" were described as those representing stock on which positive identification could not be established when received. The depot procedure was to assign a local temporary code number for the purpose of storage and issue as well as for a reporting basis to develop stock tapes listing quantity of items on hand and amount of issue.

Elaborate cross-reference lists, every Government publication on tools and equipment, sets of 104 different manufacturers' catalogues, photographs, blueprints, and various types of measuring and weighing apparatus were part of the elaborate set of working tools explained, demonstrated, and then made available to the men attending the school who would carry SODTICIOAP into the field.

The subject of stock numbers, tool markings, etc., came in for considerable discussion. The Ordnance Department, early in 1943 agreed that there should be only one numbering and identification method for tools and equipment; namely, the Federal Standard Stock Numbering System. By giving all

tools and equipment a universal number, it was recognized that interchangeability and proper substitution could then be effected not only in Ordnance but among all Army services. However, through the many years of tool production, and because of the great quantities of tools that were procured prior to 1943, there were thousands of items in Ordnance depots not recorded under Federal standard stock numbers. The warehouse or stock-numbers system used for storage-and-issue purposes in depots was that of item code numbers. Therefore, the adoption of the Federal Standard Stock Numbering System meant also the changing of the coding system in the depots.

Particular emphasis was given to the consolidation of stocks, reducing the range of items, and providing for interchangeability or substitution to the greatest degree possible. It was pointed out that similar tools serving the same purpose, made by various manufacturers, in many instances were recorded, stocked, and issued separately in the depots. It was directed that such items were to be picked up by the men working in the depots, placed in the same bins or locations, and interchangeability lists perfected to insure the use of all available stocks.

Through the use of proper consolidation and interchangeability, not only would the service to our using organizations be improved, but thousands of man-hours would be saved in labor and handling from the depots to the actual user. Furthermore, the additional tools made available through this process would enable revisions of production schedules of hard-pressed manufacturers and permit the fabrication of more critical items. At the same time it would permit cancellation of orders where overages were established.

The SODTICIOAP teams were to make use of a tabulation of all temporarily coded items prepared for them by the depot. This document would then be checked with the locator files of the depot and systematically analyzed with cross-reference and other informative data provided for this work. When proper identification was positively established and the authorized applicable stock number assigned, the item would be removed from the temporarily coded classification and changed to the permanent records of the depot to be included in the consolidated stores report. When positive identification could not be established by the teams, such items were to be listed in special tool-identification sheets and forwarded to the Central Directing Committee at Detroit where positive identification and disposition would be made.

The function of the Central Directing Committee—for SODTICIOAP—established at the Office of the Chief of Ordnance, Detroit, for the duration of the program was explained. All directives and orders were to be issued from this source. It was to be the clearinghouse of all information to and from the men operating in the field.

Experts on artillery tools from Rock Island Arsenal and on fire-control tools from Frankford Arsenal were available to the Central Directing Committee, while representatives of small-arms and other types of specialized matériel were available for answering any questions that might result from information developed by the teams in the depots. Information on tools and equipment on which Federal stock numbers had not been assigned was to be forwarded to the committee where numbers would be secured by contact with the Treasury Department in Washington, D. C., and notification then given the depots for final handling.

At several points in the discussion between Ordnance and representatives of industry, the question was raised as to how the tool experts from industry would be received in Army and depot installations throughout the country. It was made quite clear to the representatives from industry that the SODTICIOAP personnel would, in accordance with military practices, report direct to the commanding officer and while working at that installation be subject to and take orders from the commanding officer or his duly appointed representative.

Eight teams, consisting of four to five industrial men, one depot man, and one Detroit Ordnance tool expert, were formed, and, after spending the final day in the St. Louis Ordnance Depot observing actual operations, they were assigned directly to eight selected Ordnance depots.

ONCE the teams were in the depots, immediate satisfactory progress was reported by depot commanders. At the Augusta Arsenal, all the tools of the "J" group—automotive common—approximating four thousand items at this installation, were changed from item code numbers to Federal stock numbers. All this stock was physically moved after dismantling old wooden-type bins and then constructing, painting, and relocating new bin sections to accommodate these items. The team was also able to identify at the depot 1,508 of 1,603 temporarily coded items which previously had not been available to supply channels.

Stocks at some locations had accumulated because of changes in Army organizations, tables of equipment, and military tactics. One such example was handled at the Lordstown Ordnance Depot where a stock of ninety carloads of tools and equipment, procured before Pearl Harbor for a specific use and no longer required, was processed. Many of these items were used to take care of emergency overseas requisitions. Other items, because of quantities involved when returned to supply channels, resulted in the cancellation of certain existing procurements covering current requirements.

At the Ogden Ordnance Depot the team arrived in time to assist in its activation as a new distribution installation. It aided in handling 1,360 items of incoming new stocks of tools and equipment in addition to their work on reclassification and substitution.

At one depot, a seemingly insignificant, unidentified item, which proved to be caliber .30 rifle cleaning brushes, when analyzed was found to represent a quantity of 700,860 brushes. The quantity, of course, brought added importance to this item. Through the Central Directing Committee at Detroit these brushes were identified and returned to supply channels.

The team assigned to the Stockton Ordnance Depot completed a study on the use of thirty-eight different types of pullers. Recommendations were submitted for the substitution of common or universal-type pullers for certain special pullers that were critical at the time. Also at this depot, many tool kits, classified as obsolete, were dismantled and the components placed in depot stocks. A number of these items were used immediately to fill back orders, thus relieving certain critical requirements.

Another example of the use of seemingly obsolete items is noted in the work of the group at the Raritan Arsenal. It was found that large quantities of gudgeon pullers on hand were listed as obsolete stock. Because of the experience of the industrial men, recommendations were made and acted upon in which certain components were added to the pullers resulting in a set capable of performing necessary mainte-

nance operations. Through this action, savings of critical material and taxpayers' dollars were effected.

Special assignments and research work done by one team were not duplicated by another, since the information or accomplishments were reported to the Central Operating Committee and passed on to all other teams in the various depots. At the Letterkenny Ordnance Depot a new system was instituted consolidating large quantities of hundreds of different types of files. It was found that maximum interchangeability could be made on this type of item.

TOOL and equipment stocks at Benicia Arsenal, located throughout various warehouses, were consolidated and moved to a central location. At the arsenal a complete check was made of all bin openings against physical stock, and 2,969 bin openings were made available through stock consolidation. This action was most important in that additional space was required in this depot for critical spare-parts stockage.

The action of a team assigned to the Port Johnson Terminal accomplished in 2 days the identification of 185 tool and equipment items that had stumped the terminal personnel at this point for some time.

In almost all the depots it was found necessary to assist a partial, or in some cases a complete, rewarehousing program. Such was the case at the Atlanta Ordnance Depot where 124 carloads of tool and equipment items were moved from several buildings and concentrated in one location where an exclusive tool-and-equipment operation was established. Items formerly subjected to weather conditions were moved from outside storage and sheds to inside warehouse locations. In some instances, it was found that tools and equipment were stocked under the manufacturer's number corresponding to the vehicle, along with common parts. Where these cases were found, tools were pulled out, identified by Federal stock numbers, and binned in the tool-and-equipment section of the depot.

At some of the large Army training centers, tool and equipment stock levels were initiated to provide sufficient quantities to take care of the Army organizations, which resulted in the release of excess stock. A program to process large quantities of unserviceable and used tools and equipment to reclamation points was inaugurated. Many usable tool and equipment items were recaptured from unserviceable vehicles from the Desert Training Center and were returned to supply channels.

It is, of course, recognized that when the missions of certain supply installations are changed, an unusually heavy load may be thrust upon certain depots. During the activation period of one depot, hundreds of car and truck loads of tools and equipment were received. It was beyond human possibility to handle these huge receipts in the usual prescribed manner because of the physical factors involved. Therefore, this material had to be unloaded and stored in any available space. With inexperienced personnel for the handling of tools and equipment at this installation, the SODTICIOAP teams were welcomed by the depot commander and immediately assigned to assist in identifying, relocating, and placing this material in proper order. Often it was necessary to open many boxes and check the individual pieces because original identification tags had been lost or obliterated while the goods were in transit.

The shortest assignment handled by a SODTICIOAP team was accomplished at the Anniston Ordnance Depot. This resulted from the excellent preliminary work at the depot whose representative had previously attended the SODTICIOAP school at St. Louis. No team was available to assign to Anniston when the program was first started, so the depot representative had placed in effect the principles of the program explained at the school. The SODTICIOAP team spent only eight days at this depot.

Certain uniform results were obtained by all depots and are chalked up on the credit side of the Ordnance ledger as follows: (1) Stock records and tapes were analyzed and items converted to applicable Federal stock numbers. (2) Assistance was given in identifying, classifying, rebinning, rewarehousing, and physically integrating stocks, and reconciling stocks with records. (3) Depot stock-locator systems were improved, and interchangeability and substitution records instituted, permitting wider use of available stocks. (4) Slow-moving or apparently obsolete stocks were analyzed, including tremendous quantities of used and unserviceable items on which appropriate action for redistribution has been taken. (5) Depot libraries were established or improved to include all Government tool-and-equipment publications, manufacturer's catalogues, cross references, aids, etc. (6) A greater appreciation of the importance of tools and equipment was inculcated by strengthening or setting up exclusive tool-and-equipment groups in depots and providing special courses of instruction to perpetuate the principles of SODTICIOAP.

THE service rendered during this program to Ordnance depots, training centers, ports of embarkation, and other Army installations has been such that a demand was created for setting up, within Ordnance, a permanent group to render technical assistance to the field on all subjects relating to tools and equipment. This group has been established at the Office of the Chief of Ordnance, Detroit.

From the standpoint of the tool-and-equipment industry, pressure was eased on many items of production by the revision or cancellation of certain contracts. In many cases, manufacturers were in a position to fabricate tools on other urgent Government contracts and also provide vitally needed items for farmers and other essential civilian use.

One industry spokesman described SODTICIOAP as a model basis of postwar planning for Government and industry in that it determined, in regard to tools and equipment, how many, what condition, and where. With this type of information available, Government decisions, based on current requirements, can achieve sensible liquidation of any excess stocks. The success of SODTICIOAP is another glowing tribute to the teamwork of General Campbell's Ordnance-Industry team combination. And as for the name, just think of the paper saved by writing "SODTICIOAP" rather than Special Ordnance Depot Tool Identification, Classification, Inventory, and Obsolescence Analysis Program!

EDITOR'S NOTE.—Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, writing on supply and maintenance in the September-October 1943 issue of ARMY ORDNANCE (Vol. XXV, No. 140, p. 321), said: "Within the realm of maintenance, perhaps even more than in supply, the necessity for uniformity of methods applies. Here specialization is important, and with that must go a recognition that to do its best job each echelon must not extend itself beyond its ability to perform nor beyond the limits of the tools and equipment available for the job assigned to it."

Readjustment of Arms Production

The Rôle of the Ordnance Department in Global War

Col. Herbert R. White

THE over-all function of the Ordnance Department of the Army is to design, develop, procure, produce, supply, and maintain the weapons of our fighting forces. This is a traditional function which the Department has been hard at work upon for nearly a century and a half in peace and in war. Today, in the midst of the greatest war of all recorded history, that function remains identically what it has always been.

The military equipment for which the Ordnance Department is responsible ranges from the smallest side arms of the individual soldier to the largest seacoast guns which guard our important harbors. It includes all types of guns and their ammunition, explosives, bombs, rockets, and all other weapons; tanks, trucks, artillery tractors, and other automotive equipment.

Army Ordnance has the obligation of providing these weapons of the highest quality, in ample quantity, and when needed for the use of our own Army; certain types of equipment must also be provided for our Navy and many types for our allies in this war. These are the "customers" of the Ordnance Department. Their requirements are our "order book." Now, after four years of intensified effort, we find that we have sufficient quantities of certain types of equipment with the result that production of such items can be curtailed.

It is the purpose of this article to explain briefly, yet fully, the method by which reduction or termination of production is decided in order that all concerned may be fully cognizant of the care and consideration which are given to every step in the entire process. This question is especially important at the moment since the welfare of American industry is intimately allied with the arms-production program.

Let it be said at the start that the Ordnance Department of the Army, ever mindful of the important rôle of American industry in the transition from peace to war, is equally concerned about the transition from war to peace. Its great objective is to keep American industry supreme at all times because the strength of American industry is always a gauge of our ability to defend ourselves.

Before describing the methods now in use for determining what production facilities shall be reduced or discontinued as sufficient reserve stocks of ordnance matériel are accumulated, let me first explain the procedures which have been long in effect for establishing the quantities and time schedules of our production program. The Ordnance Department does not in any way determine the quantities or the time schedules for its "customers." These are determined in all cases by higher military authority. In so far as ordnance requirements of the Army are concerned, these are predicated on plans made by the General Staff as to the size of the Army, the composition of its various units, and the time and place at which these fighting forces will be used. These elements are closely identified with grand strategy and are, therefore, a function of high command.

Over the years there have been developed in the Army what are termed tables of organization and tables of equipment. These determine to the last man and to the last weapon the quantities of both that will be required. In addition, there are special issues of equipment over and above the tables of organization which are based on special movement orders and special lists for special organizations. Maintenance factors over a given period of time also must be added. Of necessity, these change from time to time depending upon needs of battle. Once the troop basis is decided upon by our General Staff, it is furnished to Headquarters, Army Service Forces, and thence to the Ordnance Department which in turn computes the specific quantities of Ordnance items in conformity with the troop basis, the tables of organization, and the tables of equipment. Thus are established the basic requirements of ordnance matériel for our Army.

But in this war there are additional requirements. To the above Army requirements are added the War Aid requirements of the United Nations. In addition, there must be added the requirements of the Navy for those items which the Army Ordnance Department supplies to its sister service.

ALL these different types of requirements taken as a whole constitute the Army supply program. That program, determined by higher authority, becomes the "order book" for the Ordnance Department. The Army supply program determines the demand; the Ordnance job is to meet that demand on time.

Thus it is obvious that the Ordnance "order book" must be changed constantly as dictated by the demands of global warfare. Items which are needed in increased quantities must be placed with industry in increased orders. Items for which the demand slackens must likewise be interpreted promptly to industry through cancellations and cutbacks so that stocks of unusable matériel will not be built up in excessive quantities. This whole procedure of changing requirements can best be expressed by the three words "fluidity of war."

Thus far we have traced the composition of Ordnance requirements as embodied in the Army supply program which, as mentioned above, is a function of the War Department General Staff and of Headquarters, Army Service Forces. Now let us trace the procedure through the Ordnance Department itself to learn how accurately the program is translated into actual weapons. In the Ordnance Department, as part of its Industrial Division, there are four "product" manufacturing branches—Artillery, Small Arms, Ammunition, and Tank-Automotive.

As the orders from our "customers" in the form of the Army supply program are received, the manufacturing branches, working through the thirteen Ordnance procurement district offices place this business either in Government-owned plants or with private industrial producers. The Ordnance district procurement office proceeds to handle this business in much the same manner as does industry itself. The primary difference is the fact that in spending Government funds many statutes and regulations must be followed. The "contracting officer" is in reality not one individual but a

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The following are among the principal factors in determining changes in contract schedules to meet revisions of the Army supply program:

1. *Strategic and security considerations.*
2. *Cost—a prime consideration because it involves the taxpayer's money.*
3. *Man-power availability because of the critical situation in certain areas.*
4. *Effect on the manufacturer in relation to other work on his production schedule.*
5. *Engineering background of the manufacturer.*
6. *The manufacturer's flexibility for handling revisions of production.*
7. *Use and saving of materials.*
8. *Effect on transportation, bearing in mind minimum crosshauls.*
9. *Possibility of horizontal adjustment.*
10. *Possible use of the facility for other work in the war production program.*

ORDNANCE METHOD OF PRODUCTION READJUSTMENT

group of individuals. In each Ordnance district office, negotiations are carried on with industrial concerns to develop equitable prices, to assure performance both as to quality and quantity, schedule of deliveries, and the many other factors which enter into the procurement in large quantities of highly specialized products. In each district office, operating directly under the chief of the district, is a "board of awards." This board is made up of officers and key civilians. All papers covering negotiations of a contract are submitted to this board with the recommendation of the negotiator. The board carefully reviews the recommendations of the negotiator and either approves or disapproves the placement of a contract.

As the changing requirements of our "customers"—the Army, Navy, and the War Aid countries—necessitate cancellations and cutbacks of existing contracts, still more care is used by the Ordnance Department in determining where such cutbacks shall be made. The manufacturing branch receives downward revisions through the changes of the Army supply program. These revisions reach the Chief of Ordnance as individual item changes or, periodically, in the form of a revised Army supply program. Each "product" manufacturing branch analyzes the performance of all suppliers of the particular product involved and then prepares a tentative recommendation as to how this reduction shall be put into effect by individual producers. This is discussed with the various Ordnance district offices involved, and a final recommendation is prepared.

Following the theory that "two heads are better than one" and to assure every possible safeguard for the Army and industry, the Chief of Ordnance, in the fall of 1942, established a board of four officers (who have no participation in original procurement) to review the recommendations of the manufacturing branches in connection with substantial cutbacks and cancellations. This board is known as the "Board of Review." Upon receipt of the recommendations of the manufacturing branch, the Board of Review holds a meeting with the chief of the branch and members of his staff to review the recommended cutbacks and cancellations. Many hours are spent by this group where cutbacks are severe or where complete cancellation of orders is necessary.

There are many factors which must be carefully considered. Price is naturally very important because it involves the taxpayers' money. The labor situation in the area or the manpower availability is also given weighty consideration. The effect on the manufacturer in relation to other work in his plant is still another factor. A small plant having no other work and the many subcontractors used by larger concerns are also given serious thought.

The engineering background of a company is also carefully considered together with its flexibility for handling revisions, minimum use of material, effect on transportation to obtain minimum crosshaul, possibility of horizontal adjustment, and the use of the facility for other war work. In this latter connection, effort is made through the War Production Board to place other work in the manufacturer's plant in a minimum of time where such is possible. Security or strategic considerations must not be overlooked. When the Board of Review has made its determinations after carefully weighing all the factors mentioned above, a report is prepared by the Board of Review either concurring in the recommendations of the branches or making other recommendations based upon its analysis. The Board of Review report, together with the recommendations of the manufacturing branch, is submitted to the chief of the Industrial Division and then to the Chief of Ordnance for action. This report is then forwarded to Headquarters, Army Service Forces, for information and review. Should the recommendation involve the closing of a Government-owned contractor-operated plant, no action is taken by the Ordnance Department without the approval of Army Service Forces and the Under Secretary of War.

It is the endeavor of the Ordnance Department at all times to give industry as much advance notice as possible of pending reductions and cancellations and to further permit the tapering off of production and employment. This, of course, is not always possible because of the immediate necessity for promptly stopping production of items which, if completed, might be surplus and unusable. The Ordnance Department's obligation is first to the fighting men in battle and secondly to the American taxpayers—including American industry in all its elements. The policies of Army Ordnance are as considerate of the interests of private industry—labor and management—in decelerating the Ordnance production program as they were in accelerating it. The Industry-Ordnance team remains a team regardless of the location of the goal posts!

I can best express that thought by quoting the words of the Chief of Ordnance as recently as January 19, 1944, when he stressed the importance of the industrial supremacy of American industry: "This war is not yet won. Until it is won we must have intensified action in many Ordnance operations. But over and above that, America, to remain strong, must protect her own industrial supremacy, for only as American industry thrives during the coming years, will our military strength be able to meet its continuing obligations."

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Month by Month

Return to Brass Cartridge Cases.—The Ordnance Department is discontinuing the use of steel for the production of all artillery cartridge cases and is reverting to brass in order to save critical man-hours, machine-hours, and costs. It is estimated that the change back to brass will increase artillery-ammunition production 30 per cent and will result in a taxpayers' saving of $100,000,000 in 1944.

According to Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, "it became evident several years ago that the ammunition-program requirements could not be met with the limited supply of brass then available. The use of steel cases was a military necessity. Due to the widely different properties of brass and steel, severe manufacturing difficulties were anticipated. Nevertheless, through the interest, coöperation, and determination of the technicians and production men of American industry, the venture proved a success. Millions of acceptable steel cases were produced, the ammunition program was met, and thousands of tons of then-critical brass were released by Ordnance for the manufacture of other more urgently needed war matériel.

"Some few weeks ago, however," General Campbell stated, "a revision to the Army supply program was received by the Ordnance Department calling for a greatly reduced number of rounds of small-arms ammunition. This reduction was caused by the fact that small-arms ammunition reserves in the battle areas and at home have been built up to a safe level. The reduction in the manufacture of small-arms ammunition thus made available a large tonnage of cartridge brass for artillery cases and obviated the necessity for consideration of steel in either small-arms ammunition or artillery cases. The brass made available has been assigned to the manufacture of artillery cases.

"Steel cases cost more than brass cases, require a greater number of manufacturing operations, and yield high scrap losses. Since the inherent corrosion resistance of steel is less than brass, steel cases are not as well suited as brass cases for use in humid tropical climates and are more likely to result in long-time storage complications. When brass was available, Ordnance used brass; when brass became critical, industry achieved one of the mechanical miracles of this war and made it possible for Ordnance to convert to steel. The Ordnance Department was well satisfied with results; but now that brass is again available, and since our combat units prefer brass, Ordnance is reverting to brass."

There will be no lost motion in this reversion. The same equipment which manufactured steel cases will also manufacture brass cases. All the technical data which have been accumulated by industry in all its phases in the development of the steel cartridge case is being carefully documented and preserved so that if again a brass shortage should occur for artillery or small-arms-ammunition cases, Ordnance can rapidly go again into steel.

Genesis of the Jeep.—When the question arose some months ago as to what branch of the Army was responsible for the development of that remarkably versatile vehicle, the jeep, General Campbell, Chief of Ordnance, settled the matter once and for all with a letter to Maj. Gen. E. B. Gregory, the Quartermaster General, which gave the credit where credit is due—to the Quartermaster Corps of the Army. General Campbell wrote:

"Within recent weeks it has come to my attention that there is considerable discussion about the genesis of the jeep. I am told that one author is gathering material for a book in which he intends to present the story of the origin of this remarkable vehicle in considerable detail. In so far as the Ordnance Department is concerned, I have a deep conviction on the subject, and I am anxious that you should know about it.

"Even without the tremendously widespread public interest that has been shown in the jeep from the very first, it still would be easily one of the outstanding automotive developments of this war. All of us in the Ordnance Department fully realize that this vehicle was developed and put into production by the Quartermaster Corps prior to the time when Motor Transport was transferred to the Ordnance Department on August 1, 1942. None of the credit for this achievement belongs to the Ordnance Department, and it would be presumptuous on our part ever to allow a shadow of doubt on this point.

"Therefore, I am sending this note to assure you that anything that may be said or written on the origin of the jeep is entirely within your province and not mine. It is a very remarkable achievement for which the Quartermaster Corps and those who worked for or with it are entitled to credit. We of Ordnance join with all your other friends in giving this credit completely and gladly."

The production and maintenance of this outstanding vehicle are now the responsibilities of the Ordnance Department.

MEMBERSHIP

in the

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.....

If not now in service, was discharge honorable?.....

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References (not necessarily members of the Association).....

.....

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Signature.....

(Do not write below this line)

Application received.....

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A Résumé of War Production.—During 1943 our total war production was 50 per cent greater than in 1942. Following are data for some of the more important items:

Aircraft.—The 1943 tonnage production was about 130 per cent higher than in 1942. For the month of December the rate was nearly 235 per cent higher. The 1944 schedule calls for an increase to 325 per cent of the 1942 output. The most recent study on productivity indicates that output per man-hour has increased over 50 per cent during the last 18 months. During 1943, the United States aircraft industry produced 85,946 airplanes of all types, compared with a total output of 47,873 airplanes in 1942. Concurrent with this 80 per cent increase of production in numbers, the proportion of heavy combat types produced rose to the extent that aircraft production by weight increased from 37,000,000 pounds monthly at the start of 1943 to 84,000,000 pounds in December.

Naval Ships.—We have turned out 75 per cent more tonnage than in 1942, and at the present time our rate is 215 per cent greater. In 1944 there may be a slight falling off from current levels. It is worth recalling that in three years we have expanded our Navy from 1,076 vessels, displacing 1,900,000 tons, to 14,072 vessels, displacing nearly 5,000,000 tons—the biggest navy the world has ever seen.

James V. Forrestal, Under Secretary of the Navy, disclosed early in January that 65 aircraft carriers and 13,617 combatant naval planes were built in 1943 and said the Navy "now has in being forces which constitute the greatest sea and air striking power in the world." The carriers were six 27,000-tonners of the ESSEX type, nine of the 10,000-ton converted-cruiser type, and fifty escort carriers which are smaller ships and have been used to hunt submarines in the Atlantic.

Trucks.—Production of trucks is steadily mounting. In 1943 we turned out about 20 per cent more than 1942. Our going rate is 40 per cent higher, and our 1944 program calls for 100 per cent increase over 1942.

Ordnance.—Other significant increases during 1943 over 1942 were small-arms ammunition 140 per cent and artillery ammunition 70 per cent. Brig. Gen. James Kirk, chief of the Small Arms Branch of the Ordnance Industrial Division, has announced that a world manufacturing record was established in November 1943 when 10 American plants under contract with the Ordnance Department produced 200 per cent more carbines than the combined production of Enfield and Springfield rifles in the record month of World War I.

The total value of individual war supply contracts awarded by the Army, Navy, Maritime Commission, Treasury Procurement Division, and foreign purchasing missions, reported to the WPB in the period of June 1940 through September 1943, amounts to $138,000,000,000. The total value of facility projects stands at approximately $30,000,000,000. The $168,000,000,000 total of war supply and facility contracts does not include revisions in the estimated final cost of products under cost-plus-a-fixed-fee contracts or under contracts containing an escalator clause with respect to wage rates and materials prices.

Future Trends in Munitions Manufacture.—Cutbacks in the production of small arms, small-arms ammunition, noncombat planes, and antiaircraft equipment, plus a nearly forty per cent slash in aluminum production, have been predicted by the Office of War Information. However, the decreases will be more than offset by boosts in warplanes and some other munitions, and "no considerable curtailments" for the purpose of resuming civilian-goods manufacture can be scheduled for 1944 unless war in the European theater ends by June or July.

Arms production in 1944 is to be seventeen per cent greater than in 1943. This in itself is a cutback, since previous disclosures have estimated a gain of from twenty to twenty-five per cent.

The Navy alone has made cutbacks amounting to $2,856,000,000 in the last half year or so. Despite this trimming, the Navy's 1944 program will be $16,000,000,000, one-third higher than in 1943. Without disclosing details of naval ship construction plans for this year, the Navy in the 3 years 1945-1947 plans to build more than 500 combat vessels, 1,000 patrol and auxiliary vessels, and more than 70,000 landing craft. Both naval ships and naval planes will be delivered in greater volume this year than last, with shipbuilding alone reaching the record total of $8,000,000,000 in 1944.

More than offsetting the cutbacks will be an almost doubled production of combat aircraft, with greatly increased emphasis on bombers, a tripled requirement for high-octane gasoline, and other expansions in merchant shipping, trucks (about fifty per cent), electronic equipment, heavy guns, heavy artillery shells, ground ordnance and signal items.

Readjustments in specific categories of the war production program have been influenced by various factors. An over-all yardstick cannot be laid upon the program. For example, tank production during the latter part of 1943 leveled downward by approximately thirty-six per cent from earlier 1943 production levels. This was due in part to the greater need for ships. Available steel had to be diverted from other items. Too, there was a declining need from our allies for tanks as supplied through lend-lease. The rise in effectiveness of antitank weapons also affected the relative importance of the tank as a weapon in various types and places of battle. Some former tank facilities are now manufacturing other vehicles.

Closing of several small-arms ammunition plants has been announced in recent weeks. Some are turning to other production; some are being kept in a stand-by position should future developments require a resumption of production. This program is now tapering toward a decline of about thirty-six per cent on a dollar-volume basis from the totals of 1943. In this connection, as in a number of other cases, the explanation is one of mass production hitting its stride. Starting from virtually nothing in the way of facilities, this country, when attacked, needed to build an immediate stock pile of ammunition for defense and for troop training. There was need for all types of facilities that could quickly turn out small-arms ammunition. Once facilities were built and working, it was possible to produce such ammunition in great amounts. With a backlog for safety now built up, it is possible to cut the rate to replacement levels, releasing certain facilities for other more necessary uses.

A similar situation exists in small arms. Rifles and machine guns lend themselves to huge mass production once facilities are created. Through November 1943, production of small-arms matériel rose about eighty per cent from the January 1943 level. It is starting downward to a level thirty per cent below the November peak.

A sharp reduction has taken place in the output of antiaircraft guns for home protection. With the increase in U. S. air power, less antiaircraft artillery is needed in defense installations. Thus, the production rate on antiaircraft has been cut approximately in half from previous peak levels.

Association Affairs

PITTSBURGH POST

MORE than 1,100 members of the Pittsburgh Post of the Army Ordnance Association and their guests paid tribute to the sterling work of Frank B. Bell as chief of the Pittsburgh Ordnance District at a luncheon meeting on January 5, 1944. The meeting was held in the grand ball room of the William Penn Hotel, Pittsburgh, with Col. Herbert A. Gidney, president of the Pittsburgh Post, presiding. Leading members of industry of the Pittsburgh area were in attendance. The climax of the meeting was a showing of the film "War Department Report."

FRANK B. BELL

Mr. Bell, an outstanding proponent of industrial-preparedness activities during the past quarter century, has relinquished his duties as chief of the Pittsburgh Ordnance District to become chairman of the district's advisory board. He has been succeeded by Col. R. C. Downie, former deputy district chief.

When the Pittsburgh Ordnance District was reëstablished in 1922, Mr. Bell and Colonel Gidney served as assistants to the late Ralph M. Dravo. Mr. Bell was appointed district chief in 1930 and held that office uninterruptedly until 1941 when he resigned to become assistant chief of the Ordnance Section, Office of Production Management in Washington. When the OPM became the War Production Board, Mr. Bell continued as assistant chief of its Ordnance Section. In August 1942, he returned to the Pittsburgh District with Brig. Gen. Hugh Minton. Mr. Bell was reappointed district chief in November 1942.

His influence upon and contribution to the success of the Ordnance Department in meeting its great wartime responsibilities have always been of the highest order. A manufacturer of long experience, a gentleman of keen judgment, and a man of quiet manner, Mr. Bell has inspired industry of the Pittsburgh area and has led it to unbelievable goals of ordnance production. In his new office as chairman of the Pittsburgh Advisory Board, he will be of inestimable help in continuing the war effort.

Colonel Downie has been associated with the Pittsburgh Ordnance District since 1940. In 1942, he was appointed executive officer under General Minton, then district chief, and later in that year became the deputy chief under Mr. Bell.

The committee in charge of the luncheon and meeting was under the chairmanship of Lieut. Col. Thomas Eddy assisted by the officers of the Pittsburgh Post and Capt. W. S. Rial, public relations officer of the Pittsburgh Ordnance District.

Col. L. A. Codd, executive assistant to the Chief of Ordnance, conveyed the personal greetings and thanks of Maj. Gen. L. H. Campbell, Jr., Chief of Ordnance, to Mr. Bell and his felicitations to Colonel Downie.

DETROIT POST

AS the result of the annual election of officers held by the Detroit Post of the Association, Col. H. W. Alden was chosen to succeed himself in the office of president, and George D. Bailey was retained as vice-president. Capt. J. W. Paynter also was selected to continue his duties as secretary-treasurer of the Post.

Directors elected to serve for three years are: K. T. Keller, Stephen T. Stackpole, Oscar Webber, Colonel Alden, and Mr. Bailey. Directors elected to serve two years are: R. L. Biggers, Charles T. Bush, Phil Huber, A. M. Wibel. Directors with one year to serve are: Clarence W. Avery, H. F. Harper, George M. Holley, O. E. Hunt, and C. J. Reese.

CINCINNATI POST

AN installation of the newly elected officers and directors of the Cincinnati Post of the Army Ordnance Association was held on January 6, 1944, in the office of Col. Joseph C. Shouvlin, chief of the Cincinnati Ordnance District. Following the installation, the activities of the past year were reviewed, and plans for the coming year were considered. A dinner meeting of the Post has been tentatively scheduled for the latter part of March or early April.

The newly elected president of the Post is Frederick V. Geier, president of the Cincinnati Milling Machine Company, Cincinnati, Ohio. He succeeds Harvey C. Knowles, vice-president of Procter & Gamble Company, Cincinnati, who was chosen to serve as a national director of the Association. Charles W. Dupuis, president of the Central Trust Company of Cincinnati, is vice-president of the Post, and Maj. E. W. Harrison is treasurer.

The following are the new directors of the Cincinnati Post: Louis Polk, president of the Sheffield Corporation, Dayton, Ohio; Louis Ruthenburg, president of Servel, Inc., Evansville, Ind.; R. K. Brodie, vice-president of Procter & Gamble Company. Mr. Geier also was made a director of the Post.

Directors elected last year for the 1943-1944 term are: Col. A. W. Herrington, chairman of the board, Marmon-Herrington Company, Indianapolis, Ind.; S. E. Steinbeck, manager of the Washington office of Tube Turns, Inc., a subsidiary of the Girdler Corporation, Louisville, Ky.; Col. A. H. Pugh, president of the A. H. Pugh Printing Company, Cincinnati, Ohio; and E. A. Muller, president of the King Machine Tool Company, Cincinnati.

ST. LOUIS POST

AT the annual meeting of the St. Louis Post of the Association, held at the Scottish Rite Cathedral in St. Louis, the following officers were elected:

Lieut. Col. Edwin B. Meissner, president; Col. Merle H. Davis, vice-president; Maj. M. F. Hubbell, secretary-treasurer. The following directors also were elected: Col. Harry Scullin, Spencer Olin, P. J. Watson, Jr., Russell E. Gardner, Jr., Ben Comfort, Horace B. Deal, William M. Akin, and W. Stuart Symington.

A feature of the meeting was the presentation of Ordnance citations to Messrs. Ellis, Kludt, Nieman, and Stephens, and letters of commendation from the Chief of Ordnance to Messrs. Langford and Dunford. Mr. Gardner, deputy chief of the St. Louis Ordnance District, gave a short exposition on contract terminations, followed by a playlet burlesquing this subject. The principal address, on "Renegotiation," was given by Joseph M. Dodge, chairman of the War Department Price Adjustment Board.

With this meeting the St. Louis Post reinstated itself as an active chapter of the Association. For two war years the officers and directors have been active in Association projects, but there have been no meetings of the entire membership. A new drive for members has been initiated, and favorable results are anticipated.

NEW YORK UNIVERSITY POST

A RECENT semiannual report of the New York University Post of the Association disclosed that the members of the chapter had been engaged in a number of activities during the last half of 1943. Members of the Post attended the national convention of the American Society of Mechanical Engineers in coöperation

with the New York University Chapter of the A.S.M.E. at the Hotel New Yorker in New York City. Members of the Post also attended the national convention of the Society for the Advancement of Management in conjunction with the New York City chapter of that organization.

Members of the Post attended the national meeting of the Army Ordnance Association held on January 19, 1944, at the Waldorf-Astoria Hotel in New York, and also made arrangements for the attendance of the local chapters of the two societies mentioned above.

Soldier-students in the Army Student Training Program and officer cadets at New York University, as well as Ordnance military personnel at the University, have been invited to participate in the activities of the Post, and the admission of such military personnel to membership in the chapter is being considered.

Thomas R. Torian is president of the Post, Robert F. Borg is treasurer, and Stanford Schwartz is secretary. Maj. Carlos de Zafra, Ord. Res., is faculty adviser.

Ordnance Soldiers Honored

TWO commissioned officers and one noncommissioned officer of the Ordnance Department have been honored with the Legion of Merit for exceptionally meritorious service, and three other Ordnance soldiers have been awarded the Soldier's Medal for acts of heroism.

Col. Harold W. Rehm, of Grosse Pointe, Mich., received the Legion of Merit for exceptionally meritorious conduct in the performance of outstanding services. The citation reads: "As commanding officer and acting construction quartermaster of the Detroit Tank Arsenal, and as commanding officer of the Tank Engineering Office, also in Detroit, from January 1, 1942, to August 7, 1942, he distinguished himself by achievements beyond what had been reasonably expected or predicted. The months he gained beyond his schedule in building the Detroit Tank Arsenal and achieving quantity production of the M3 medium tank proved to be of immense importance in the strategy of the war when these tanks, produced with unexpected speed due largely to his outstanding forcefulness and ingenuity, played a prominent rôle in turning back the German threat against Alexandria in 1942. The engineering improvements and adaptations he guided so brilliantly at the Tank Engineering Office were of immensurable benefit to speed of manufacture and to the fighting power of American tanks, self-propelled gun mounts, and tank destroyers."

2nd Lieut. Philip Heyman (then Staff Sergeant), of Brooklyn, N. Y., received the Legion of Merit for exceptionally meritorious conduct in the performance of outstanding service on the staff of the Field Artillery Training Center School, Fort Bragg, N. C. The citation reads: "By professional skill and ingenuity he designed and constructed many unusual and highly valuable aids for the instruction of officers and enlisted men attending the school."

Mstr. Sgt. James Lodl, Jr., of Waiaula, Oahu, received the Legion of Merit for his actions during the Japanese attack on Oahu when he accompanied a wrecking crew under enemy fire and succeeded in clearing a crucial highway of damaged vehicles and obstructions. "Subsequently," the citation states, "he remained on duty night and day in charge of an automotive-maintenance shop, directing the operations necessary to the maintenance of important transportation. Through his initiative, mechanical ingenuity, and devotion to duty, he has not only conceived and developed ideas which have materially contributed to the war effort, but on numerous occasions has applied his resourcefulness, knowledge, and experience to the prevention of loss or failure of Government automotive equipment. In addition, and as the result of long hours of experiment, he made valuable contributions to the technique of the employment of motor vehicles in amphibious operations."

Tech. 5th Grade Stanley W. Phillips, of Spraggs, Pa.; *Pfc. Howard E. Huey,* of Greenburg, Pa.; and *Pvt. Clement C. Fejfar,* of Yankton, S. D., each received the Soldier's Medal for "heroism at an Ordnance ammunition depot in the Southwest Pacific Area on October 13, 1943."

William D. Ennis Retires

THE retirement on March 1, 1944, of William D. Ennis as Humphreys Professor of Engineering Economics at Stevens Institute of Technology, Hoboken, N. J., has been announced by Dr. Harvey N. Davis, president of the college. President Davis said that Professor Ennis's resignation because of ill health was accepted with sincere regret and stated that the executive committee of the trustees has designated Dr. Ennis professor emeritus from the date of his retirement.

Professor Ennis graduated from Stevens with the Class of 1897 and received from his alma mater the honorary degree of doctor of engineering in 1934. His service in the first World War was as chief engineering officer at the Watervliet Arsenal. Later, he served as technical adviser to the War Department Claims Board at Washington. Following this, he was one of the founders, with Campbell Scott, E. P. Goodrich, and the late George B. Ford, of the Technical Advisory Corporation of New York. In September 1928, on the invitation of President Davis, Professor Ennis devoted part of his time to lecturing at Stevens, and the following year, upon the founding of the Humphreys Professorship by Arthur G. Glasgow, and others, as a memorial to Alexander C. Humphreys, second president of the Institute, Professor Ennis became its first incumbent.

Dr. Ennis is the author of six college textbooks, besides many professional papers and articles in technical magazines, and has been a speaker in frequent demand on engineering economics topics before a variety of organizations. He is a member of the National Panel of Arbitrators and was recently appointed a panel chairman and public representative by the National War Labor Board.

Necrology

WILLIAM R. BEATTY died on September 8, 1943, at his home near Hammond, Ind., and with his passing the heavy-machine-tool industry lost one of its leading figures. Mr. Beatty was active until shortly before his death in the management of the Beatty Machine and Manufacturing Company of Hammond, a concern he founded twenty-six years ago.

As a young man he worked with an iron and steel company in Pittsburgh, Pa., and subsequently became general superintendent of the New Castle Forge and Bolt Company, at New Castle, Pa. Later he was Chicago sales manager for the Williams-White Company of Moline, Ill. In 1917 he organized his own business, manufacturing heavy metal-working tools.

Mr. Beatty had served as president of the Hammond Chamber of Commerce, and his civic work in that community was widespread. Mr. Beatty's position will be filled by his son, L. C. Beatty, who has been serving as president of the company.

NOTICE also has been received of the deaths of the following members of the Association: Lieut. C. Henry Amon, East Orange, N. J.; Walter M. Balluff, Davenport, Iowa; H. L. Brueggemann, Palos Park, Ill.; Eugene B. Clark, Buchanan, Mich.; Alfred L. Eustice, Chicago, Ill.; John P. Fitch, Hartford, Conn.; L. M. Forster, St. Louis, Mo.; I. C. Gellman, Rock Island, Ill.; Joseph J. Henderson, Caldwell, N. J.; H. K. Jackson, La Grange, Ill.; Thomas E. Kilby, Anniston, Ala.; E. R. Kyler, Columbus, Ohio; George T. Ladd, Pittsburgh, Pa.; W. P. Langhammer, Springfield, Mass.; E. R. Leonard, Washington, D. C.; I. K. Stearns, Bryson City, N. C.; James A. Stillman, New York, N. Y.; William W. Varney, Washington, N. J. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

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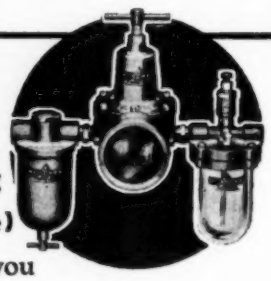


British Ordnance

Antitank and Medium Artillery

Maj. Gen. H. Rowan-Robinson

WHEN I first set eyes on Britain's new 17-pounder gun about a year ago, I feared that the General Staff had adopted a mistaken policy. It seemed to me then that, because of the limitations set to the weight of tanks by the load-carrying capacity of bridges and culverts, the Axis powers were unlikely to produce any armored fighting vehicle that could not be adequately countered by, say, a 12-pounder, and that therefore the adoption of a 17-pounder would entail unnecessary sacrifices in mobility, in rate of fire, and in the number of rounds that could be carried without making excessive demands on transport.

However, the General Staff was not only right but right in most timely fashion. On the very day the monster German tank —the Mark VI Tiger, on which such high Nazi hopes were set— took the field in Africa, the 17-pounder, its most doughty opponent, also made its first bow in public. The two antagonists did not actually meet that day, but they were battling with each other soon afterward.

In its first action in January 1943, the 17-pounder, firing at a range of 1,500 yards, blew off a Tiger's turret; but it was not seriously engaged until late in the following April when it greatly helped to defeat an enemy "spoiling attack" in the Western Desert by destroying three tanks with three successive rounds. A little later, one 17-pounder wiped out six tanks, including two Tigers in hull-down positions, before itself being put out of action.

Tactically, the normal use of the 17-pounder is offensive. Where, however, it has been employed defensively, its relatively long tank-killing range enables it to be sited either far back, thus giving extra depth to the antitank zone, or, alternatively, far to a flank where, screened by the ground from view and fire, it can enfilade the enemy's probable line of advance.

At 1,000 yards it can completely destroy the heaviest tanks that have yet taken the field. It is superior to the German 88-mm. gun both ballistically and in its capacity for quickly tackling any target that may appear. Surprisingly enough, though a most effective antitank gun, it was produced in five months after the designs had been approved—a speed of production four times greater than the normal peacetime rate.

Characteristics of the 17-pounder

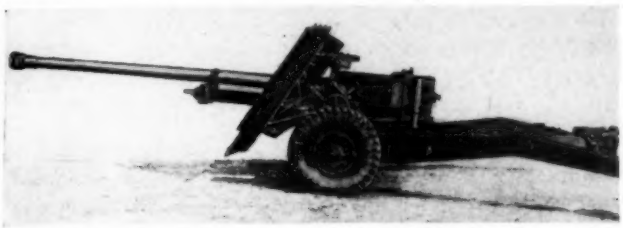
Maximum angle of elevation	16½ deg.
Maximum angle of depression	6 deg.
Maximum angle of traverse	30 deg. right or left
Caliber	3 in.
Weight of projectile	17 lbs.
Weight of charge	8 lbs.
Weight of complete round (fixed ammunition)	35 lbs.
Weight of gun	16¼ cwt.
Weight of carriage	42 cwt.
Weight behind tractor	3 tons
Projectile	Armor-piercing shot

General Rowan-Robinson is the author of numerous works including "The Campaign of Liao-Yang," "Artillery—Today and Tomorrow," "Some Aspects of Mechanization," "Further Aspects of Mechanization," "Security," "A Ministry of Defense," "England, Italy, Abyssinia," "Sanctions Begone!" "Imperial Defense," "Strategy in Four Dimensions." He was chief instructor in artillery at the Royal Military Academy from 1911 to 1914; military governor of Libau, 1919; colonel commandant and G.S.O. 1, India, 1921 to 1927; inspector general of Iraqi Army, 1930 to 1934. He was engaged in operations in Southern Kurdistan from 1930 to 1931; North Kurdistan, 1932. He is a battalion commander, British Home Guard; Gold and Silver Medalist, Royal Artillery Institution; Gold Medalist, and first and second Trench-Gascoigne Prize Essayist, Royal United Service Institution. He is a major general in the British Army and is a Companion of the Bath, of the Order of St. Michael and St. George, and holds the Distinguished Service Order.

The gun consists of a body and a breech mechanism, the former being composed of a barrel, a muzzle recoil brake, and a breech ring. The muzzle recoil brake, which is secured to the muzzle end of the barrel by a locking ring, has side vents and internal baffles. It has the effect of reducing recoil, thus giving greater steadiness to the mounting. The breech mechanism is of the vertical-sliding type. As the gun runs out after firing, a semiautomatic gear causes the breech to be opened, the cartridge to be ejected, and the striker to be recocked.

THE carriage has a split trail and is towed by a tractor. It can be given maximum traverse without moving the trail legs. The trail legs are connected by a supporting bracket in which the axletree carrying the pneumatic-tired wheels is located. Each of the wheels is provided with a hand-operated brake. The saddle, which carries the cradle, is connected to the supporting bracket by a pivot pin around which it is rotated, within limits imposed by stops, by the operation of the traversing gear, the latter being facilitated by two rollers interposed between saddle and supporting bracket. For splinter protection a double shield is secured to the saddle with brackets.

The cradle, which carries the recoil system and the gun, has two trunnions which are accommodated in bearings in the saddle. The operation of the elevating gear causes the cradle to move in the vertical plane by pivoting on its trunnions. The recoil system consists of a hydraulic buffer and a hydropneumatic recuperator contained in the cylinder block to which the gun is secured by two straps. The carriage is provided with an open sight and a sighting telescope.



THE BRITISH 17-POUNDER ANTITANK GUN

In the unceasing struggle between guns and armor, it is armor that usually sets the problem and the gun which has to solve it. Has the top weight been reached for tanks (and consequently for antitank guns) that are to be used in mobile warfare? If not, are antitank guns heavier than the 17-pounder to be designed, or will armies be content to deal with the new steel monsters by the self-propelled field gun? It will be interesting to see the answers produced by the several belligerents.

In her artillery research during the period between the wars, when money for armaments was tight, Britain adopted two methods. Mechanical traction enabled a somewhat heavier weapon to be employed as the normal equipment of field artillery than did horse traction. To combine this with economy, the 18-pounder field gun was bored out so as to increase its caliber from 3.3 to 3.45 inches and the weight of its projectile by 7 pounds. To enable it also to do the work of the obsolescent 4.5-inch howitzer, this 18-pounder field gun was converted from a gun into a gun-howitzer.

For a heavy (or medium) field gun, Britain needed something more accurate and with a longer range than the 60-pounder. This was achieved, though at a slight loss in weight of shell, by inserting a liner in the bore of the 60-pounder, reducing its caliber from 5 to 4.5 inches. Later, however, it was found that a more powerful projectile was required for medium artillery, and a new gun-howitzer—the 5.5-inch—was designed accordingly. The two weapons—the 4.5-inch and the 5.5-inch—are almost identical in appearance and have a common carriage. Only one—the 4.5-inch—will therefore be described, but the characteristics of the two pieces are set forth on the following page for comparison.

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Sparkling Clear, water-in-oil cooling compound emulsion facilitates work inspections without stopping tools in metal-cutting and grinding operations. (Data Sheet # 242)

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Wherever there's tough work to be done, in any theater of the war, you will find Allis-Chalmers tractors equal to the job. They have PROVED their ability to "take it" on a variety of operations. Besides clearing jungles and building roads, they are widely used to dig tank traps, construct bridge approaches, airports, landing strips, dispersal areas and new bases, haul big guns and handle a multitude of other jobs. Never-say-quit power and rugged construction, flashy pick-up and quicker maneuvering ability, plus high speed operation, enable them to take what comes in stride!

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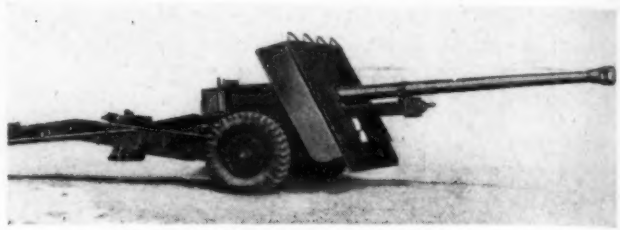
British Ordnance

Characteristics	*4.5-in. Gun*	*5.5-in. Gun*
Weight of gun	1 ton, 18 cwt.	1 ton, 16 cwt.
Weight of gun and carriage	5 tons, 15 cwt.	5 tons, 13 cwt.
Total behind tractor	6 tons, 5 cwt.	6 tons, 3 cwt.
Length	26 ft.	24 ft.
Weight of shell	55 lbs.	100 lbs.
Shipping tonnage	30 tons	30 tons
Max. elevation	45 deg.	45 deg.
Max. depression	5 deg.	5 deg.
Traverse	30 deg. right or left	30 deg. right or left
Charges	3	4
Muzzle velocity	1,250-2,250 f.s.	875-1,675 f.s.
Range	11,000-20,500 yds.	6,800-16,000 yds.

The 4.5-inch gun consists in the main of a loose barrel, jacket, breech ring, and removable breech bush. The breech mechanism is a single-motion device, the breech opening being closed by a parallel screw arranged so that it can be locked or unlocked by rotation through one-twelfth of a revolution. Obturation is obtained, as is usual where a brass cartridge case is not used, by the expansion of an asbestos pad which is squeezed by the shock of discharge between the front face of the breech screw and the mushroom head of the axial vent against the entrance to the chamber.



Right Side View of the 17-Pounder

The perimeter of the carriage conforms to the construction usual in British field carriages in that it is built in two main portions: (1) the superstructure, which consists of the cradle and saddle and provides the necessary movements of the gun in action; namely, recoil and recuperation, elevation and depression, and top traverse; (2) the basic structure, which consists of the trail, the saddle-supporting bracket, the axletree, and the wheels and provides for a steady support in action and the means of transport.

THE carriage is of the split-trail type, giving a 4-point support. The cradle carries the gun and the recoil arrangements, the whole pivoting vertically on the saddle by means of the trunnions. Interposed between the cradle and the saddle is a "balancing gear," consisting of spring presses which counteract the muzzle preponderance due to the trunnions of the cradle being far in rear of the center of gravity of the gun. For ease of traverse, the saddle, with cradle and gun, turns on a pivot which projects into it from the saddle-supporting bracket and rides on rollers interposed between it and the roller path.

To bring the gun rapidly into the loading position from angles of elevation over twenty degrees without interfering with the sighting arrangements, a "quick-loading gear" is interposed between the cradle and the saddle, the elevating arc during the process of loading being made to pivot loosely on the trunnions of the cradle by the operation of a hand lever on the right of the cradle.

The recoil system comprises a hydraulic buffer, with a "cutoff" gear to shorten the recoil as the elevation increases, and a hydropneumatic recuperator.

British Ordnance

The trail consists of two legs and the saddle-supporting bracket, the legs being hinged to hinge bolts in the latter. The spades are secured to the rear of each leg by locking levers when in the firing position and carried in housing brackets on the upper surfaces of their respective legs when in the traveling position. The saddle-supporting bracket forms the means of attachment for the legs and the support for the saddle and carries the traversing arc. It has three vertical borings at the rear, two for the hinge pins of the legs and the third for the pivot which projects into the saddle. On the underside, at the front, is a horizontal boring for an axletree hinge pin which forms the connection between bracket and axletree. Recesses are cut in each side for the ends of the axletree to enable the latter to move in a vertical plane so that bracket and legs can take up a horizontal position on irregular ground without throwing strain on the hinge pins.

There is only one projectile—a high-explosive shell. It carries a bursting charge of nearly four pounds of TNT and a small smoke box. It is equipped with a No. 119 graze-and-impact fuze. The detachment consisting of ten men can, within five minutes, bring the gun into action and fire five rounds.

The 4.5-inch gun which, like the 25-pounder, is in effect a gun-howitzer, was introduced to replace both the 60-pounder gun and the 6-inch howitzer. It is an improvement on both those pieces as regards its range which is 20,000 yards as against the 16,000 yards for the 60-pounder and 11,400 for the 6-inch howitzer, and it is therefore particularly valuable for harassing fire and counter-preparation.

Britain's ordnance experts designed a carriage which would be equally available for either the 4.5-inch or the 5.5-inch howitzer-gun. This was no easy problem, for a common factor had to be arrived at between the actions of two pieces of ordnance. The dual-service carriage, fully pneumatized, finally passed its tests, and it then became possible to go ahead with its production on the scale necessary to equip the British Army and the allied armies with suitable medium artillery.

TWIN 6-POUNDERS FOR COAST DEFENSE

LIEUT. COL. R. G. T. FLETCHER

TOWARD the end of the last war, the development of high-speed unarmored torpedo craft, used with outstanding success by the Royal Navy in 1919, produced a corresponding requirement for a coast-artillery gun capable of breaking up attacks by such craft. The only weapon of this type in use was the 12-pounder, designed at the end of the nineteenth century, which suffered from the disadvantages of a comparatively slow rate of fire, inadequate deflection compensation for fast-moving targets, and a slow and cumbersome method of applying corrections. In addition, it was necessary to relay the gun after each round.

It thus became necessary to develop a new weapon whose principal characteristics must be rapid fire, an adequate weight of shell (bearing in mind the vulnerability of motor torpedo boats), uninterrupted laying, and the ability to correct its fire onto a highly maneuverable, fast-moving target with minimum delay.

To obtain rapid fire, a new type of breech was adopted and fixed ammunition used. The rate of fire thus obtained was then doubled by incorporating a second gun into the mounting, each gun being loaded and fired independently of the other.

An entirely new principle was evolved to solve the problem of continuous laying. Hitherto, if a travel correction to the left was required, the layer's telescope was thrown out of alignment to the right of the target by the required amount, and then gun and telescope were traversed together, the telescope on the target, and the gun the same amount to the left. In the newer development, however, the telescopes were fixed parallel to the normal axis of the guns, and all corrections were applied, both for line and range, by the No. 1 of the detachment, whose controls moved

Colonel Fletcher is attached to the Royal Regiment of Artillery, British Army.

INGENUITY

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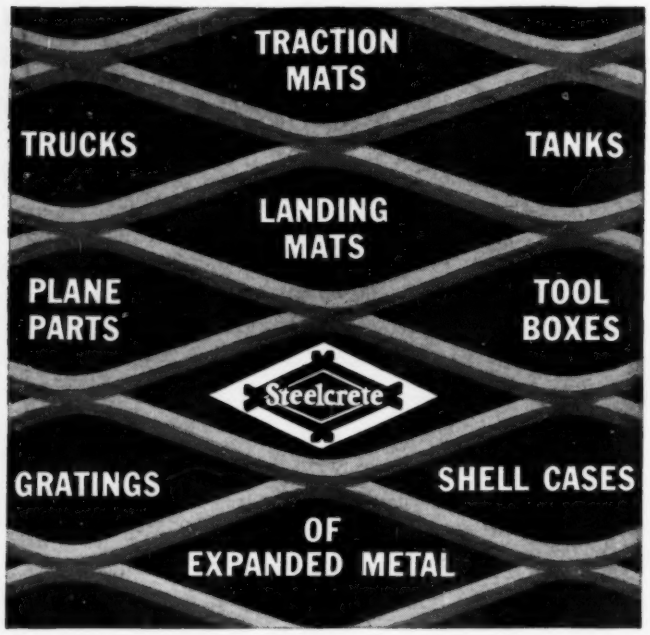

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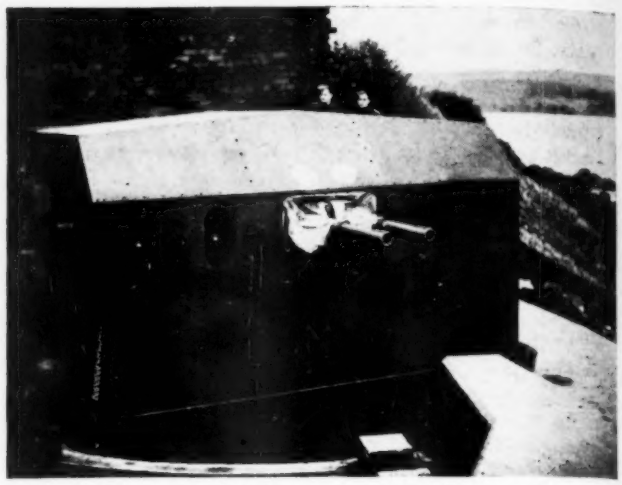
the gun barrels only, either in the horizontal or vertical plane. This enabled line and elevation layers to concentrate solely on keeping their telescopes continuously on the target. Fitted with an autosight, capable of smooth, swift traverse, and with backlash almost totally eliminated from all its gearing, the 6-pounder twin pilot model was now ready for its trials.

It is notable that this first gun was capable of seventy degrees elevation for use in an antiaircraft rôle. An overruling decision, however, that a dual-rôle gun was only half efficient in either rôle, brought its muzzle to the earth, and it is only now, ten years later, that it has again been made capable of defending itself against air attack.



Twin 6-Pounders in Armored Coast-Defense Mount

Early trouble was experienced over ammunition. The gun would normally be employed by night, firing over an illuminated area. The flash from the muzzles, occurring once every second, blinded the layers, and a flashless propellant was essential. This introduced the further problem of smoke from the flashless propellant. Though less of a handicap than flash, there were occasions on windless days when fire had to cease temporarily to allow the smoke to clear. Remote control was the answer, and the primary method of fire control is now by means of a director sited behind and about twenty feet above the gun. Quadrant elevation, bearing, and corrections are electrically transmitted to dials on the gun, whilst direct laying still remains as a secondary method in case of a breakdown.

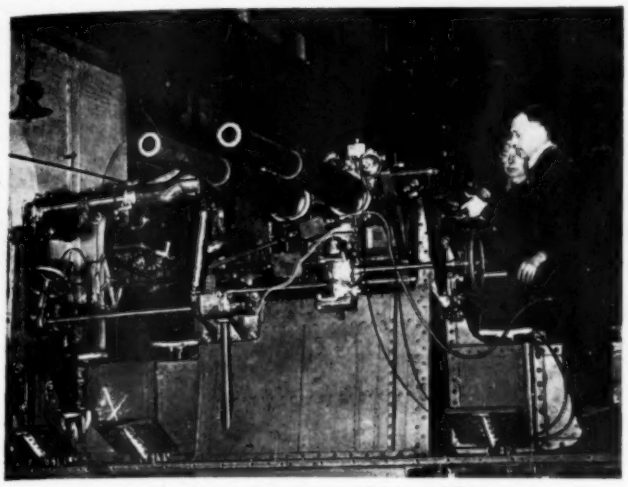
Since the mounting is fitted with a splinter-proof shield open only at the back, the noise during an action precludes the giving of verbal orders or the use of a loud-speaker, and a system of light signals is therefore necessary. These can be operated either from the director or by the No. 1 on the mounting. Tracer ammunition is used and the fuze is extremely sensitive, the shell detonating equally well on water or on the target, so that even near misses produce a damaging splinter effect.

Before 1939, the gun was installed in all major ports at home and abroad and was everywhere enthusiastically received by coast gunners. It was in the early hours of July 26th, at Valetta Harbor, Malta, that the 6-pounder twin was first called upon to prove its worth in battle. Indications had been received of the approach of hostile vessels, but these appeared to turn away when twelve miles distant from the island, and though the sounds of engines had been heard at intervals, nothing was seen until, at about 4:40 A.M., a lookout saw a fast boat close inshore. Almost simultaneously an explosion occurred on the breakwater, and the illuminated area lights were exposed.

The motorboat that had first been seen was now engaged at 200 yards range and sunk in three rounds; 5 more craft were observed about 1,000 yards distant heading for the Grand Har-

British Ordnance

bor. These were engaged by six 6-pounder twins; three were sunk outright, and two turned away damaged. A lull of half an hour succeeded this engagement, and then two almost stationary objects were detected 3,000 yards away. Again the 6-pounders opened up, and the motorboats (for such they were) sprang into life. A lively action ensued at long range, with the motorboats



WORKMEN ALIGN SIGHTS OF TWIN 6-POUNDERS

jinking, zigzagging, and turning completely through 180 degrees in an incredibly short time, but the end was inevitable, and both craft exploded and sank. Finally, when dawn came, two surviving motorboats drifting 8,000 yards offshore were flushed by a 6-inch battery and finished off by the Royal Air Force.

So ended this ill-fated attack, and thus did the 6-pounder twin prove conclusively that the confidence of designer and user in its ability to defeat the motor torpedo boat had not been misplaced.

THE BRITISH "BAZOOKA"

A POWERFUL new lightweight infantry weapon, comparable in function to the American bazooka, has been developed by the British. The 33-pound weapon, known as the "piat," fires a 2¾-pound bomb which, it is claimed, can pierce four inches of the best armor plate with the force of a 75-mm. gun. It has been successfully tested in combat by Canadian troops in Italy, where it was found to be especially effective in close fighting against tanks and pillboxes.

The weapon is easily carried by one man and can be brought into action within a few seconds. A spring mechanism takes most of the recoil so that it can be fired from the shoulder with the forepart of the weapon rested. Used in this fashion, it can disable a moving tank at a range of one hundred yards. With the butt placed on the ground so as to give the barrel elevation, the piat can knock out enemy transport, machine-gun nests, and similar targets at ranges up to 350 yards.

Its bomb is filled with high explosives which detonate on impact with the target. The propellent force is derived from the explosion of a cartridge in the tail assembly. The main part of the weapon is a light steel tube enclosing a spring developing 200 pounds' pressure. When released, the spring carries forward a steel rod which fires the cartridge in the tail of the bomb; the resulting explosion propels the bomb and at the same time recompresses the spring, automatically recocking the weapon.

The name "piat" is derived from the initials of the official name —"projector, infantry, antitank." It is being produced in Britain in quantity and has been introduced into Canadian training camps.

The American bazooka is a metal tube somewhat more than fifty inches long and less than three inches in diameter.

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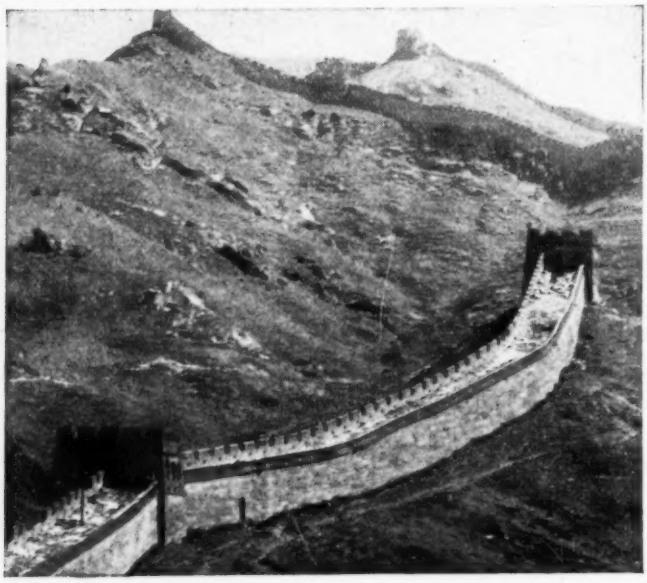

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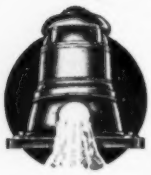

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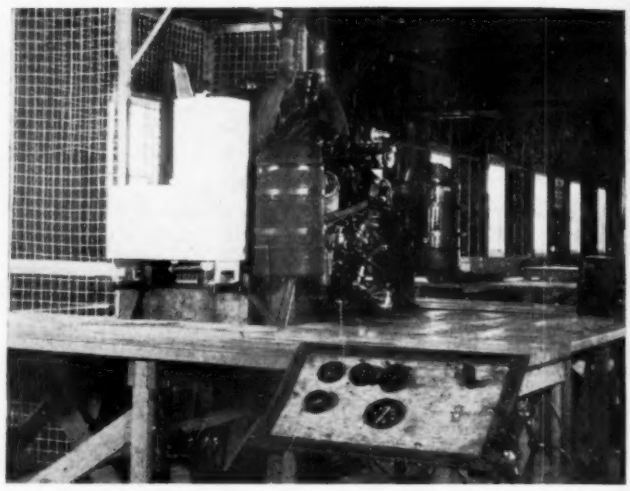
Professional Digest

Tank Destroyers Develop New Engine Mount

Lieut. L. R. Barnhill

NEW engine mounts, first of their type in the Army, are being used at the automotive department of the Tank Destroyer School, Camp Hood, Tex., to teach trouble shooting on radial engines operating under full loads at full throttle. Five of the mounts will be in operation when the project is completed in the near future. The mounts support the old reliable 9-cylinder, 400-horsepower, R-975-C1, Continental Red Seal engine that served with distinction for several years in the Air and Armored Forces before being added to Tank Destroyer power units.

The problem facing officers of the Tank Destroyer School's automotive department was to find a test mount that would permit operation of the engine at 2,400 revolutions a minute at full throttle and support it as nearly as possible in the same manner as it is mounted in armored vehicles. The plan was to familiarize students in the classroom with the engine as they would encounter it under field conditions so that they would be able to service it without loss of time in the combat zone.



Control Panel and Decking of Engine Mount

The first step was a lengthy study of the test mounts used for these engines by the Air Forces at Kelly Field, Tex. Here the Tank Destroyer officers soon determined that the 2-point suspension mounts used by the airmen were unsuitable for their use. They needed a mount with 4-point suspension similar to that required by the radial engine when it is adapted for use in armored vehicles.

The Armored Force mounts, using heavy, complex water brakes to produce engine loads, also were discarded by Col. F. A. Hornisher, department director and a veteran of the Armored Force. He demanded a simple arrangement that would leave the engine clear of needless encumbrances. The result is something new in Army instruction on radial-engine test mounts. The engine is supported between 4 upright 6 by 8 H beams sunk 33 inches in a 24-ton slab of concrete. Side braces of 2¾ by 3½-inch H beams provide additional safety for the mount against torque stress.

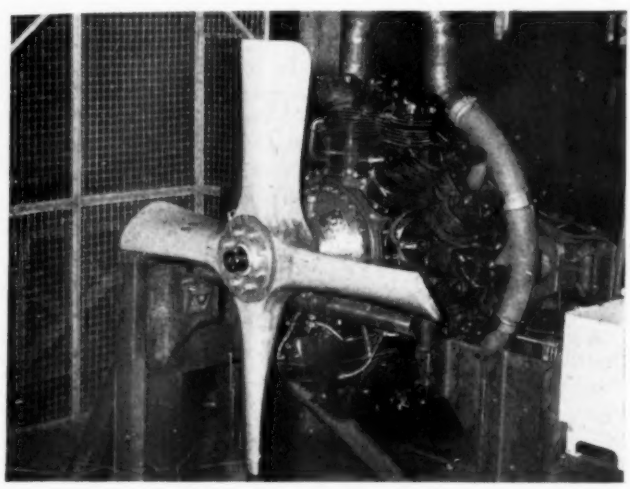
A 4-bladed test propeller was decided upon to provide the engine load, and the trouble began. First the modified nose section left the projecting crankshaft too short to mount the conven-

Lieutenant Barnhill is attached to the Tank Destroyer School, Camp Hood, Tex.

tional propeller hub, and construction of special hubs required procurement of War Production Board priority. In the course of time this was received, and the officers turned to other problems.

Through their Kelly Field studies they were able to sidestep several technical difficulties that might have seriously delayed completion of the project. For one thing, they learned that the engine must be mounted high above the floor to prevent the propeller from creating a whirlpool below the engine. The "dead space" in the center of such a whirlpool would cause overheating in the bottom cylinders. The officers overcame this difficulty by mounting the engine with the propeller hub six feet above the floor. They also learned that cooling shrouds could be removed to simplify work on the engines, but that cylinder baffles had to be retained.

Next came the tedious job of calibrating the test prop. Each of its four blades had to be shortened by approximately 7½ inches so that it would provide the exact amount of resistance to permit the engine to operate at 2,400 r.p.m. under full throttle. Engineers of the Dallas branch of the Continental Motors Corporation



FRONT VIEW SHOWING TEST PROPELLER

assisted in the first installation, but men within the department did their own work on the other four. Through the assistance of the Camp Hood Ordnance shops, the men have built a balancing machine that will permit them to do all the propeller work on the post.

As far as possible, the officers used standard parts from SNL G104 in the installations, but when they came to the carburetor cutoff, throttle linkage, and wiring, they were on their own. There was nothing in the parts list that would fill their needs, so they turned to with brake-rod yokes and pieces of scrap and built a carburetor cutoff linkage to the solenoid switch. More scrap and ¼-inch cold-rolled steel were used to make the throttle linkage extending to the control panel, fifteen feet to the left rear of the engine. The control panel contains all the essential elements of the armored-vehicle panel. There the operator has the oil-pressure and temperature gauges, ammeter, master battery switch, fuel-cutoff switch, magneto booster and starter switch, and tachometer.

The gasoline tanks now in use were salvaged from M3 half-tracks, but plans are under way to draw gasoline from an outside storage tank to remove the fire hazard within the classroom. The 9-gallon oil reservoir and oil-cooling system also are salvaged parts. They are attached to the H-beam supports on the left side of the engine. Just below them are the two standard 12-volt tank batteries that provide electrical energy to start the engine.

Post engineers coöperated in various phases of the work. They built protective metal mesh screens about the front of the engines. The screens measure 10 by 6 feet with 2-foot sides. Angle iron provides a steady frame. The engineers built an exhaust system of 20-gauge steel from plans provided by the automotive

You could sense the progress of the war by the changing types of fighting equipment being built at the Fitzgibbons plant. It goes from the defensive phase, to the offensive phase, to the Victory phase. We may not say much about this equipment. But we *can* say this. Here at Fitzgibbons we have no illusions about the termination of the war. We know how the equipment we are now building is going to be used. We are not discounting the tough road to travel before the end is reached.

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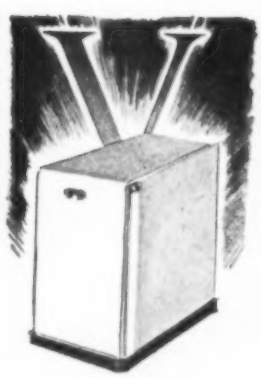
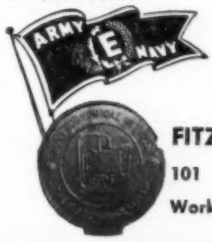


The Army-Navy "E" flag, emblem of production excellence, flies proudly over the Fitzgibbons plant.



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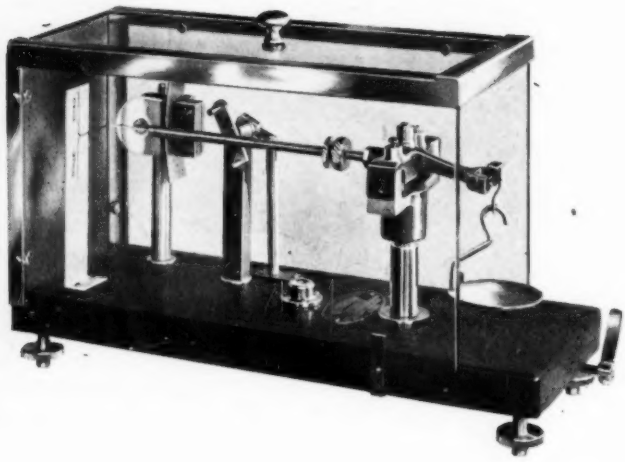

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Professional Digest

department and installed the present gasoline-supply system. It will also be their job to provide the outdoor gasoline storage tank.

The new course of instruction centering about this engine mount consists of forty-six hours, most of it spent in practical work. It is open to battalion motor officers and mechanics who have previously received in-line engine instruction. First they disassemble the engines to study the structure and function of each part. This is followed by assembly and a study of the reasons for 50 and 100-hour checks. Then comes the introduction to "live" engines. The instructor makes maladjustments in the engine and then turns it over to the students to locate and correct the trouble according to specific procedure. It is the procedure used to locate and correct troubles that is stressed throughout the course of instruction.

In the final examination, students are required to diagnose trouble within an engine that is operating under full load at full throttle. Only location of the trouble is required in the examination. Because of limited time, the students are not required to make the necessary correction to return the engine to normal operation. They do, however, learn to make these corrections during the course.

Through such training the department believes that it is turning out specialized motor officers and motor mechanics who will understand the necessity for proper maintenance of tank-destroyer engines to prevent field breakdowns that often become serious problems for Ordnance. Should troubles arise which are normal with any mechanical device, these men are qualified to locate and correct them. Tank destroyers are thus kept in their primary rôle—to move speedily into position and destroy tanks.

JET PROPELLED AIRCRAFT

FIGHTER airplanes employing jet propulsion engines soon will be in production, having passed experimental tests successfully. In a joint U. S. Army Air Forces-British R.A.F. statement, issued by Gen. H. H. Arnold, Commanding General of the AAF, it was revealed that the new-type fighter aircraft have improved jet-propulsion engines which eliminate propellers.

Jet-propulsion engines were originally of British design. Work was started on these engines in Great Britain in 1933 by Group Captain Frank Whittle. The Air Ministry placed its first order for an aircraft using jet-propulsion engines in 1939 with Gloucester Aircraft Company, Ltd., of Gloucester, England. The engines were to be built by Power Jets, Ltd., in a special factory in England to whom Group Captain Whittle was loaned.

Full information about this jet-propulsion engine was disclosed in July 1941 to the United States Army Air Forces who at once asked for an engine to be sent to the U.S.A. and the engine which had made the first flight was sent to the General Electric Company in September 1941.

The first of these engines was ready for test in less than six months. At the same time the Bell Aircraft Company was given an order to build an aircraft suitable to operate with two of these engines, and the first flight in the United States was made in less than twelve months. Several hundred successful flights have been carried out since then by American pilots in the United States and by British pilots with the British aircraft in England, many of them at high altitudes and extreme speed and all without a single mishap.

General Arnold, the British Air Ministry, and the Ministry of Aircraft Production have directed that plans be made for the production of a sufficient quantity for training purposes both in the United States and in Great Britain. The USAAF is allotting a number of these to the U. S. Navy for additional trials and experimentation.

The maiden flight of the first experimental jet-propelled aircraft in the U. S. A. took place October 1, 1942. This was the first successful operation of a combat plane using the jet-pro-

Professional Digest

pulsion principle. Robert M. Stanley, chief test pilot of the Bell Aircraft Company, was at the controls on the initial flight. The next day, Brig. Gen. (then Col.) Laurence C. Craigie flew the aircraft, thus becoming the first Army officer to fly a jet-propelled military aircraft in the U. S.

The period of secrecy cloaking the plane extended from July 1941 to January 6, 1944, during which time it was never the subject of public comment or speculation. Throughout the more than two years, executives and many workers of the General Electric Company and of Bell Aircraft Corporation, and military personnel in Washington, D. C., at Wright Field, Dayton, Ohio, and other points had knowledge of the jet-propulsion plane. A number of newspaper, magazine, and trade-paper writers and executives also are known to have come into information concerning the plane.

It was due to the sound security judgment of all these individuals that when the formal announcement of the jet-propulsion plane's successful development was announced it came as a surprise to the Nation at large. The enemy probably also was unaware of the extent to which jet-propulsion development had been carried by the United States, a fact attributed directly to the upholding of security by individuals involved.

The plane is still without an official public designation, but during the years of development it has been known variously as "Putt-Putt," "Squirt," "Hush-Hush," "Siberia," and "Super Secret."

The prime difference in the outward appearance of the jet-propulsion plane in contrast with others is that it does not have a propeller. Once, when the plane was transported by truck from one testing site to another, a dummy wooden propeller was attached, successfully cloaking its identity.

When the first plane was ready for shipment across the continent for testing it was disassembled by Bell Aircraft and crated in a single box. Military personnel, living aboard a caboose, escorted the craft. The plane and its engines have been protected always by a 24-hour guard system.

A New Mustang Combat Plane

THE Army Air Forces has sent a new and improved version of the North American P-51 Mustang combat plane into extended action in the long-range Flying Fortress assault upon German industry. Greater speed, longer range, and a much higher service ceiling are outstanding characteristics of the improved aircraft.

The Mustang is powered with a Packard-built Rolls-Royce Merlin engine of 1,500 horsepower, with a 2-stage, 2-speed supercharger. It has a 4-bladed propeller. The weight of the craft has been sharply increased from the approximately 9,500 pounds of the early versions.

The speed of the original Mustang was announced as approximately 400 miles an hour. It can now be revealed that the new models have a 400-mile-plus speed. Likewise, the service ceiling has been increased from approximately 30,000 feet to well over this figure.

The Mustang retains its dual characteristics as a fighter-bomber and an escort fighter. In its rôle as bomber it is capable of carrying a 1,000-pound bomb load. As an escort fighter it is capable of efficient operation for long distances.

The "Black Widow"—A Powerful New Night Fighter

THE Black Widow, a powerful night fighter, is the newest combat plane of the Army Air Forces. The plane's development started more than three years ago and the contract for the first model was let to Northrop Aircraft, Inc., of California, in January 1941. It was designated the P-61.

The Black Widow is the outgrowth of intensive research and development on the part of technicians of the AAF and of Northrop, directed toward production of a powerful and effec-

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Professional Digest

tive aërial night combat weapon, equipped with the latest devices. The Black Widow is heavily armored and armed. It is powered by two Pratt & Whitney engines. Details of the Black Widow's performance remain secret. However, it is described as having a fairly long range and possessing effective speed and climb characteristics.

The "Sea Wolf"—New Torpedo Bomber

A NEW torpedo plane, the Sea Wolf—the most powerful of its type in the world—which was announced by the Navy recently, will be built from a design developed by Chance Vought Aircraft Division of United Aircraft Corporation. The new craft—a valuable addition to the Navy's arsenal of weapons for smashing Japanese sea power—is to be manufactured in quantity by the Consolidated-Vultee Aircraft Corporation at Allentown, Pa.

The prototype of the Sea Wolf—which was designated the XTBU-1—was built by Chance Vought, and the experimental flight tests were carried out by Vought. The Sea Wolf is the product of the same engineering staff which developed the Navy's famous Vought F4U-1 Corsair shipboard fighter, which is playing a vital rôle in the current offensive drives against the Japanese in the South Pacific.

Announcement of the new torpedo bomber was made recently by Rear Adm. Ralph Davison, Assistant Chief of the Bureau of Aëronautics, in a speech dedicating the new Corsair Field adjoining the Consolidated-Vultee Aircraft Corporation plant. The new plane weighs approximately eight tons.

Flak Helmets for Flyers

A NEW fashion in headgear being worn by combat crews of the Army Air Forces, has been developed and is being produced by the Army Ordnance Department. Some members of bombardment crews, in performing their specific duties, have more room in the aircraft than others. As a result, two types of steel helmets

The M3 Flak Helmet, Left, and the M4, Right

have been developed. One, the M3, was developed by the Ordnance Department, the other, the M4, was developed by the Air Forces. Both types of helmets, however, are being produced by Army Ordnance.

The M3 fits over the regular leather helmet worn by flyers. It has protecting steel flaps to cover the earphones and these flaps are attached to the body of the helmet by hinges. When the steel helmet is put on, the flaps are held up so they do not interfere with the earphones, which protrude slightly. The flaps are then lowered over the earphones and held in place by a strap under the chin.

Extremely low temperatures are encountered in high-altitude

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flying, and a coating of flock is sprayed on the helmet to prevent a flyer's skin from freezing to the metal should he touch the new headgear. Flock is a substance similar to cotton lint or peach fuzz.

M4-type helmets were developed by the Air Forces. They are made of shaped plates to fit the different contours of the head, and are enclosed in a canvas cover. This helmet, which resembles a skull cap, also fits over the regular leather flying helmet. M3 helmets can be worn by most of the members of the bombardment crew, but the M4 is primarily for those who man the guns in the turrets where space is very limited. These helmets are for protection against low-velocity fragments from antiaircraft shells, and head injuries have been reduced considerably since the crews of combat aircraft have been wearing them.

AVIATION-ORDNANCE DEMOLITION SQUADS

ALL Aviation-Ordnance units now operating in Italy and the Southwest Pacific are equipped with demolition kits. Demolition has both defensive and offensive value. Ordnance "dynamite" squads, in addition to their ordinary duties of "passing the ammunition" to bomber and fighter planes, are especially trained in the fine art of destroying repair shops, bombs, disabled planes, gasoline drums, and everything else of value to the enemy should a speedy retreat from some advance airfield be made necessary by the swiftly changing fortunes of war.

Contrariwise, whenever our invasion armies register new gains and specially trained Ordnance bomb-disposal squads from Ground Forces troops are not immediately available, Aviation-Ordnance units comb newly captured enemy airfields for concealed time-delay bombs and duds as well as booby traps, mines, and other enemy-prepared surprises.

Because of long experience with explosives of all kinds, Ordnance troops performed heroic impromptu demolition and evacuation work in the early months of the war. Ordnance units attached to the immortal 19th Bomber Group in the Philippines provided the bombs and machine-gun ammunition for all missions of American heavy bombers that tried vainly to beat off the avalanche of Jap planes that descended on the islands. During the crisis, they repaired machine guns, patched up damaged planes, built new airfields and, near the end, prepared mines and demolition equipment. Ordnance officers were the last Americans to leave Mindanao in the Philippines and Malang in Southeast Java.

NEW ORDNANCE WIND TUNNEL

THE Ordnance Department has developed one of the highest continuous speed air tunnels in the world for testing blockbusters of revolutionary design that will be showered on Germany by the big new high-speed Army bombers. The new tunnel is designed to build up a wind draft in excess of 700 miles an hour.

Air is blown through a circular tunnel, made of fabricated steel plates electrically welded, by a 94-inch centrifugal fan. The fan is driven by a 2,300-volt motor developing 400 horsepower and is given its initial impulse by a magnetic starter.

The heart of the tunnel is the narrowest part of the shaft where the greatest wind speed is developed. It is here that bomb components are tested to determine the effect of air pressures on the falling projectiles.

Bomb parts are suspended inside the tunnel, the air is set in motion, and the arming wire is withdrawn. Parts which may rip off are driven into a recovery room at the end of the tunnel and are examined there by technicians seeking the effect of the terrific wind pressure.

An unusual feature of the equipment is that it is possible to read the wind speed in miles per hour on a specially calibrated dial on the control board. This kind of computation has never

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been accomplished before on a wind tunnel. It is expected that the tunnel will solve many problems in connection with block-busters—or any other type of aërial bomb—which fall through the air at a speed exceeding 500 miles an hour.

Captured Enemy Weapons

CAPTURED Japanese and German arms are aiding experts of the Ordnance Department in their constant search for latest information about enemy equipment. Approximately 1,100 major types of Axis ordnance equipment, comprising roughly 600,000 separate items, have been received at the scientific testing laboratories at Aberdeen Proving Ground, Md., and at six arsenals in this country. Each item has been examined, not only to determine its characteristics but also its effectiveness against American tanks and armored vehicles. After testing, the enemy matériel is shipped to Army training centers, where it is used to acquaint American troops with weapons they eventually must oppose.

"The Japs in particular are keen on getting their hands on American battle tools because they are better than they possess," said an Ordnance Department expert. In support of this, tests have disclosed that the latest Japanese rifle, a manually operated bolt-action weapon with an increased bore of caliber .303, is inaccurate at a range of more than 350 yards, while the American M1 rifle, the Garand, is accurate at greater distances.

It has been found that the Japanese light machine gun fires 30 rounds in 3 seconds, but, since it has only a 30-round magazine, its effective rate of fire is reduced to 200 to 300 rounds a minute. It is accurate at short distances, but at 500 yards it does not compare with the caliber .30 Browning, which fires 500 to 600 rounds a minute.

Supplementing the information gleaned from the captured weapons by our Ordnance specialists are reports from British and Russian intelligence officers and from "underground" sources. Ordnance officers at the various battle fronts embody their findings in reports cabled daily to Ordnance Department headquarters at Washington, D. C., where they are studied thoroughly and analyzed. Samples of captured weapons and ammunition follow these up-to-the-minute reports.

Maj. Gen. G. M. Barnes, chief of the Ordnance Department's Technical Division, speaking before the Society of Automotive Engineers in Detroit, stated that Jap weapons lack firepower and that this disadvantage will prove fatal as the United States solves its logistic problems and pushes forward to ram home our power drives.

"Jap infantry weapons are very light and portable," General Barnes declared, "and can be carried into the thickest jungles. However, they lack firepower. The Japs are not good artillerists, and their artillery weapons cannot be classed as satisfactory, except perhaps for fighting under jungle conditions. They are not strong in the engineering of automotive vehicles and are failing to keep pace with American automotive developments.

"The quality margin between our weapons and the Japanese will grow wider as the war progresses. Japan, in the early stages of this war, due to the terrain and difficulties which we faced in spanning the great distances of the Pacific, has avoided the full impact of American military and naval forces. As our full strength develops in the Pacific, the weight of our heavier and more powerful weapons will be increasingly felt by the Japanese, and this should tend to decrease their resistance as we move relentlessly step by step into the Japanese Empire."

The German Army, General Barnes indicated, possesses the best enemy weapons. He revealed that the Germans have developed a wide range of vehicles from a 1-ton vehicle for use with infantry to a large 18-ton vehicle for hauling heavy types of artillery. The key attribute of these vehicles is interchangeability. The engines are of the same type, and the tracks are basi-

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cally alike. A minimum number of component parts have been used.

One interesting feature is that the largest of these vehicles have a dual fuel system. A small tank is located under the dashboard connected through a selector valve. This tank contains high-volatility fuel for starting the Maybach gasoline engine. After starting, the engine is capable of running on low-grade fuels. The German 8-wheeled-drive reconnaissance car, while good in sand, is disappointing in mud and is being encountered in decreasing numbers. German motorcycles are well engineered and, coupled with sidecars, drive on both the rear wheels, thus giving the vehicle added mobility.

In the tank field, General Barnes declared, the light Mark I and Mark II models have been withdrawn as too feeble to stand the pace of modern tank warfare. The Mark III and Mark IV models have been constantly improved, the former nineteen times and the latter seven times, but they proved inferior to American armor in the North African campaign. A 36-ton Mark V tank has been rarely seen on the battlefield. The heavy Mark VI "Tiger" tank is being knocked out by our hard-hitting bazooka.

"The more we study the engineering details of German equipment," General Barnes said, "the clearer it is that this war was planned for many years—even before Hitler. One of the great advantages of this long period of ordnance engineering planning has been the reduction in the number of components required for German equipment. Half-track vehicles, for example, require a minimum number of engines, and many of these engines are also utilized as tank engines. The reduction of spare parts makes possible the delivery of a greater volume of weapons to the battlefields from a man-power and matériel standpoint and requires fewer technical troops for maintenance in the field. While Germany held this engineering edge in the beginning, she has now definitely lost this position. Again, she has underestimated the engineering flexibility of this Nation.

"In any peacetime preparedness program for the years to follow, these lessons should prompt us to provide—through Congress—sufficient funds for the Ordnance Department to work with industry to continuously develop complete lines of special ordnance weapons with components primarily standardized for war. Thorough scientific and engineering preparation for war will insure that full advantage of the great industrial strength of our Nation can be quickly mobilized when alerted by the 'Pearl Harbor' of the future."

CAPTURED JU 88 AIRPLANE REVEALS CONSTRUCTION SECRETS

GERMAN manufacturing methods and present-day aëronautical trends have been revealed to the Army Air Forces through study of the captured JU 88 airplane which was flown to the United States recently for testing by the A.A.F. Matériel Command at Wright Field, Dayton, Ohio.

Findings yielded by the study include: a key to its versatility, simplification of German manufacturing procedures, a device for blowing racks and bombs loose from the ship in an emergency, the method employed in overcoming icing hazards, and the wide latitude possible in armament installations and use on the plane. On the debit side, the Matériel Command technicians report that quarters in the JU 88 are badly cramped, the Germans apparently trying to jam everything into the smallest possible space. Lack of meticulous machining is evident in the housing of engine and flight instruments.

The ship apparently was designed for many tasks, varying from high-altitude bombing to ground strafing, mine laying, and night fighting. For these jobs the ship carries armor to protect the pilot and radio operator and some additional protective armor.

The plane ordinarily is equipped with 7.9-mm. guns. For hazardous work these can be augmented in any number of ways with additional guns and cannon. Hollow, explosive-filled bolts are

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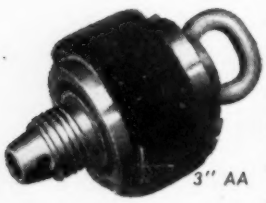
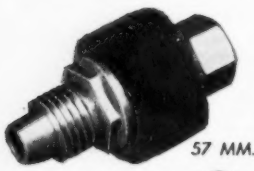


Above is shown the popular 155 mm. brush such as is used for the famous Long Tom Gun. Other size brushes are used for anti-aircraft batteries, tanks, and pack howitzers. Brushes are also provided for cleaning breech mechanisms and elevating gears.



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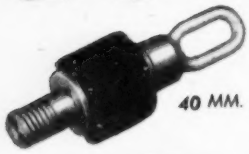

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employed to hold the external bomb racks under the wings. Apparently the purpose is to allow the pilot to jettison his bombs, racks, or both, in a hurry if necessary or desirable. A press on a button blows racks and bombs loose from the ship. Hydraulic lines are plainly marked and arrows are painted on them at intervals to indicate fluid flow, and thus facilitate repair work.

Christie Tank Inventor Dies

John W. Christie, inventor of the Christie high-speed tank, died at his home at Falls Church, Va., January 11, 1944. Following the end of World War I, Mr. Christie spent several years and much money developing light, medium, and heavy tanks. He also developed the wheel-and-track tank which could be used with tracks across country or as a high-speed wheeled vehicle on roadways. None of his tanks, however, were adopted as standard by the U. S. Army. It is reported that he spent all the money received for his inventions in developing a plan for "flying artillery" whereby lightweight high-speed tanks could be carried by airplanes and dropped undamaged and ready to fight.

In addition to his work on high-speed tanks, Mr. Christie patented the self-propelled fire engine, the front-wheel drive for motor cars, the standard turret track for battleships, gun mounts, and gun carriages. He also developed the first amphibious tank and, later, a marine tank that could ride on the deck of a submarine and take to the water when shallows were reached.

Tests of Mr. Christie's tanks began at Fort Meade, Md., in 1928, and they were accepted for limited use by the Army Tank Board in 1930.

British-American Patent Pact

The little-known British-American Patent Interchange Agreement, two years old on January 1, 1944, has spurred the battle of production for victory in World War II with glowing results. Under this agreement there has been a free flow of patent rights and scientific and technical information. Aircraft, radio, and ordnance particularly have benefited by this united effort. Great savings have been made in time and money through having specialists in their particular fields contribute their talents and inventions in solving problems that demanded speedy solution in the stress of war.

The program involves highly confidential equipment that is a major factor in the forthcoming victory. Government contractors, under the plan, have received absolutely free, in a great number of cases, patented and unpatented ideas of real value to the prosecution of the war.

The procedure whereby Government contractors take advantage of the services offered them under the terms of the Patent Interchange Agreement is relatively simple. The contractor files his request through the contracting officer or the technical representative of the service or agency with whom he has made his war contracts. A simple requisition is prepared and forwarded to the British representatives. Inasmuch as the British Government has broad powers under the Patents and Designs Act, the information and licenses can be made available promptly.

The directions and regulations under which such reverse lend-lease aid can be obtained from the United Kingdom and from several of the other United Nations by War and Navy Department contractors are set forth in War Department Procurement Regulations, paragraphs 1109-1111 (available from Headquarters, Army Service Forces, War Department, Washington 25, D. C.) and Navy Procurement Directives, paragraphs 14001-14021, inclusive (available from the Office of the Under Secretary of the Navy, Navy Department, Washington 25, D. C.). Copies of the Patent Interchange Agreement and of other lend-lease and reciprocal-aid agreements may be obtained upon application to the State Department, Washington 25, D. C.

Book Reviews

THE ARMY READER. Edited by Lieut. Col. Karl Detzer. Indianapolis: Bobbs-Merrill Company. $4.

THIS volume presents a broad, comprehensive digest of the Army of the United States, its wide scale of operations, and some of its major problems. The editor, who in civil life is a well-known writer, is attached to the headquarters staff of the Army Service Forces. His book of 469 pages contains excerpts from the writings of well-known authors who have contributed to the national magazines and the daily press. For human interest and excellence of presentation their writings offer some of the most forceful and illuminating descriptions of the American Army at war. There are three major divisions of the book under the following titles: "Men of War and Why They Fight," "Prelude to Battle," and "Combat Report."

The second section, "Prelude to Battle," contains the narratives relating to the Army Ground Forces, the Army Air Forces, and the Army Service Forces. We object strenuously to the treatment given the Army Service Forces, for in no part of its one hundred pages is the Ordnance Department so much as mentioned. Yet, by actual statistics, the Ordnance responsibility is today some eighty-one per cent of the Army Service Forces' industrial load, not to mention the vast Ordnance research, training, and field-service functions.

This glaring omission is not mentioned through any sense of hurt pride—the Ordnance record is far too glorious for that. But the editor claims "the purpose of this book is to tell the story of the American Army." Our Army today without its superior weapons of every category, without the vast trained complement of Ordnance personnel who keep that armament in battle condition, without the great Ordnance research and development forces, and most of all without the tremendous Industry-Ordnance production achievement—our Army without Ordnance—would be mere cannon fodder.

The plain fact is that these armament functions are one of the most outstanding parts of the United States Army's current record. They are solely and essentially the work of the Ordnance Department over the past five years of emergency operation and the past fifty years of industrial-mobilization planning. Yet Colonel Detzer has produced a volume of 469 pages on the Army in which the word "ordnance" appears not more than five times and in each case in a very obscure and secondary connection. To say the least, such a picture of our Army is decidedly out of balance. He has tried his hand at picking an all-star team and has left out one of the hardest hitting linesmen! O. E. D.

HOW THE ARMY FIGHTS. By Lowell M. Limpus. New York: D. Appleton-Century Company. $3.

HAVING read several of the "how" books of the present war, this reviewer confesses that he approached the present volume with a degree of skepticism. But the author does not attempt to give the generals and the Nation directions on how to win the war. He confines himself to a masterful description of the new weapons and equipment of warfare and to interestingly written descripions of basic conceptions of the supply, movement, and operations of modern armies.

However bloody and difficult was the last war, it was nevertheless a simple one compared with the present conflict from the standpoint of disposition, use, and continuous supply of matériel. Logistics have been expanded and multiplied on a scale never before visualized. A fundamental problem has been to keep the enemy in check on great strategic circles while enough supplies

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Book Reviews

were concentrated at points of offensive which were not always the most easily reached geographically. The author has not only given an easily read description of the important weapons and their use, he has also given a comprehensive picture of the overall supply problem. G. S. B.

Fifteen Decisive Battles of the World. By Sir Edward S. Creasy with nine new chapters by Robert H. Murray. Harrisburg: Military Service Publishing Company. 620 pp. $3.

A REVISION of Creasy's classic text of 1851 still leaves the rapid reader unimpressed. However, the fifteen added battles are well chosen and enhance the book. The fifteenth battle added—Mukden—with its implications and probable influence on future events as seen at the time, is reflected in present-day warfare and ties this military textbook securely to World War II. A reference book for the military library and solid reading for the tactical student. T. K. V.

Military Psychology. By Norman C. Meier. New York: Harper & Brothers. 395 pp. $3.

MILITARY psychology is the application of the elements of that science to the military problem. Selection of personnel with civilian skill which can be used effectively in the military setup may be done wisely or unwisely. In the latter case, sooner or later shell shock or mental breakdown manifests itself. This book discusses simply and directly the problems of adjustment and selection of personnel and the solutions which may be applied. Bibliographies are included at the end of each chapter. Lieut. Gen. Ben Lear, U. S. Army, outlines the need for a wide understanding of this subject in the foreword to the book. T. K. V.

The Suzy-Q. By Priscilla Hardison. Boston: Houghton-Mifflin Company. 170 pp. $2.

THE Suzy-Q is a Flying Fortress—a particular Fortress—called for the nickname of the author. She is the wife of the pilot of the Suzy-Q, the flagship of the 19th Heavy Bombardment Group. She attempts to understand her husband's experiences in battle and to tell his story and that of his crew on their 'round-the-world flight with their many encounters with the Japs. She listened to the stories told by the crew, asked questions, and has presented a readable and understanding book. T. H. S.

A Short History of the Chinese People. By L. Carrington Goodrich. New York: Harper & Brothers. 260 pp. $2.50.

AN associate professor of Chinese at Columbia University adds to the numberless histories of this ancient people, telling their story again in the light of present-day events. A book to be added to the library of the student of Chinese history, but dry reading for one who is casually interested. H. S. T.

Singapore Goes off the Air. By Giles Playfair. New York: E. P. Dutton & Company. 273 pp. $2.50.

"IT IS alleged that he (the Singaporean) was ill-prepared for war. That is true. It is further alleged that when the enemy marched in he was still romping around the dance floor. That is the purest hokum."

This unfair and inaccurate generalization is expanded in this journal-diary. "If my readers decide that there was folly, negligence, idleness, self-indulgence, and even poltroonery in civilian Singapore, I hope they will agree there was also wisdom, diligence, hard work, self-sacrifice, and great bravery. Much that happened in my experience between December 8, 1941, and February 11, 1942, was regrettable. But by no means was it all shameful." A champion of discredited Singapore thus states his thesis.

Where whisky was known as "stengah"; where the war was

Book Reviews

regarded as an unwarranted intrusion on the personal pleasures of the Europeans; where the white administration failed to inspire the Asiatic to prepare for inevitable invasion; where those in power did not attempt to appreciate or consider the Asiatic mind—that was Singapore. The author very carefully shows the transition to a state of individual anarchy, with preservation of self and liberty the rule. He was the Director of Talks and Productions of the Malaya Broadcasting Corporation and in a few short weeks in Singapore lived a lifetime. He has told of it in great detail, carefully and clearly. T. K. V.

THE FRAMEWORK OF BATTLE. By Lieut. Col. John G. Burr. Philadelphia: J. B. Lippincott Company. 254 pp. $3.

THIS book is for the armchair strategist as well as the military student. It is written in layman's language by an officer who has a fine background of training and schooling in the technique of tactics. The planning of campaigns, the movement of the elements of armies, the tie-in with the established principles of warfare, are worked out simply using actual battles, with places and people, strategy and guesswork. The book carefully illustrates all phases of campaigns with excellent drawings. A fine book, very modern, up-to-date, and instructive. T. K. V.

HAND TOOLS. By Wagener and Arthur. New York: D. Van Nostrand Company. 174 pp. $1.75.

PREPARED by two instructors at the Henry Ford Trade School, this handbook does not instruct in the uses of hand tools but does describe them completely, with many illustrations, and indicates the scope of their use. This is a very complete handbook and gives in condensed form information that is otherwise contained in hundreds of books and catalogues. V. T. K.

PAN AMERICAN ECONOMICS. By Olson and Hickman. New York: John Wiley & Sons, Inc. 480 pp. $4.50.

THE nations constituting the Pan American Union, located south of Canada in the Western Hemisphere, are economically intermeshed with the rest of the world. This book is concerned with international aspects, particularly those regarding the United States, since we are the leading Latin-American traders and investors. The influence of World War II is recognized and discussed. Since this book deals with a single phase of international policy with regard to Latin America, it advocates no specific over-all principles in that regard. It employs statistical, historical, and descriptive techniques, uses charts in profusion, has an appendix with many tables, an extensive bibliography and index. The chapter subjects are well chosen, and each ends with a paragraph of "conclusions" which is a joy to the casual student of the subject. T. K. V.

WHAT TO DO WITH ITALY. By Gaetano Salvemini and George LaPiana. New York: Duell, Sloan & Pearce, Inc. $2.75.

THE authors of this book, two professors, have already achieved a writing reputation that should be sufficient to carry this volume to success. But by no other means could it be brought there. It follows the inevitable pattern of too many so-called "timely" books; *i.e.*, the author has a bright idea for a solution of a world problem which could be stated in a short magazine article, but he prefers to drag it through tortuous book pages padded with filler rehashed from published works.

In this case the bright idea is a republic for Italy, but the word "republic" has many meanings. Classroom "liberals," such as the authors, would disclaim any adherence to radicalism and communism through anarchy, but their theories point the road to both. The French Reign of Terror was precipitated by theorists who sought to implant a democracy upon a people unprepared

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Joseph J. Cheney, President

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Book Reviews

for it. The authors' hate for the monarchy is undisguised, and their hate for the Vatican is but thinly veiled under fatuous attacks on "reactionary clerical groups," especially that old bugbear, the Jesuits. The book will not be taken seriously by those who understand true democracy. G. S. B.

Joe Foss—Flying Marine. By Walter Simmons. New York: E. P. Dutton & Company. 160 pp. $2.50.

JOE FOSS, an average American boy from South Dakota, joined the flying Marines, embarked for Guadalcanal, and became the greatest American ace. He is now a major, holds the Congressional Medal of Honor, and has equaled Rickenbacker's record with his flying circus of Grumman Wildcats. T. H. S.

Blitz German. By Dr. Rudolph Brandl. Harrisburg: Military Service Publishing Company. 174 pp. $0.75.

ONE of a series of language guides for invasion and occupation personnel to use. It follows the familiar pattern, giving usual phrases in everyday language classified into natural groups. It is a dependable and intelligent aid. H. T. S.

The Slide Rule and How to Use It. By Sommers, Drell, and Wallschlaeger. Chicago: Wilcox & Follett Company. 208 pp. $2.98.

A WORKBOOK containing hundreds of examples to be worked on the slide rule. Each step is clearly explained and the build-up is slow to the more intricate problems that may be solved. The book has a place for and is furnished with a 10-inch slide rule for beginner's use. This is a self-teacher which is well worked out and is more than adequate for its purpose. T. K. V.

The Wright Brothers. By Fred C. Kelly. New York: Harcourt, Brace & Company. 340 pp.

A BIOGRAPHY authorized by Orville Wright. The Wright brothers are presented as individuals with problems and interests apart from those connected with the development of the airplane. The patent suits in which they became involved and the complete story of the exiling of the Wright plane from the Smithsonian Institution are fully presented. S. T. H.

Napoleon and Modern War. By Col. C. H. Lanza. Harrisburg: Military Service Publishing Company. 158 pp. $1.

THE 115 maxims of Napoleon are annotated to show their continued application as military principles to modern war and in consonance with developments which are commonplace today but undreamed of by the little Corsican. The author has carefully selected his comments anent each maxim. T. K. V.

Books Received

Ammunition. By Melvin M. Johnson, Jr., and Charles T. Haven. New York: William Morrow & Company. $5.

The Growth of the Red Army. By D. Redotoff White. Princeton: Princeton University Press. $3.75.

Elmore. By Theodore J. Ritter and Robert W. Gadbois. Richmond: The Dietz Press, Inc. $1.

How to Write a Military Letter. By Corp. David Klein. Harrisburg: The Military Service Publishing Company. 136 pp. $1.25.

Wage Incentives in Wartime. New York: Consolidated Management Consultants, Industrial Engineers.

Steel Products Manual. New York: American Iron and Steel Institute. 215 pp. $2.50.

Marching Home. By Richard Hart. New York: Arco Publishing Company. 182 pp. $1.89.